# BTeV Tracking System

## Pixel Vertex Detector (WBS 1.2)
## Straw Tracker (WBS 1.6)
## Silicon Tracker (WBS 1.7)

**Simon Kwan (WBS 1.2)**

**Alan Hahn (WBS 1.6)**

**Luigi Moroni (WBS 1.7)**

# Overview

- **Brief description of the BTeV tracking system**
  - Pixel vertex detector
  - Forward tracker (Straw & Silicon strips)
- **Details of each sub-system**
  - Project requirements & Description
  - Project organization
  - Cost, Schedule,  and Critical path
  - Milestones
  - Risk Assessment
  - Responses to DOE CD-1 recommendations
- **Presentations prepared for the breakout sessions**
- **Conclusion**
- **Glossary**

# Introduction

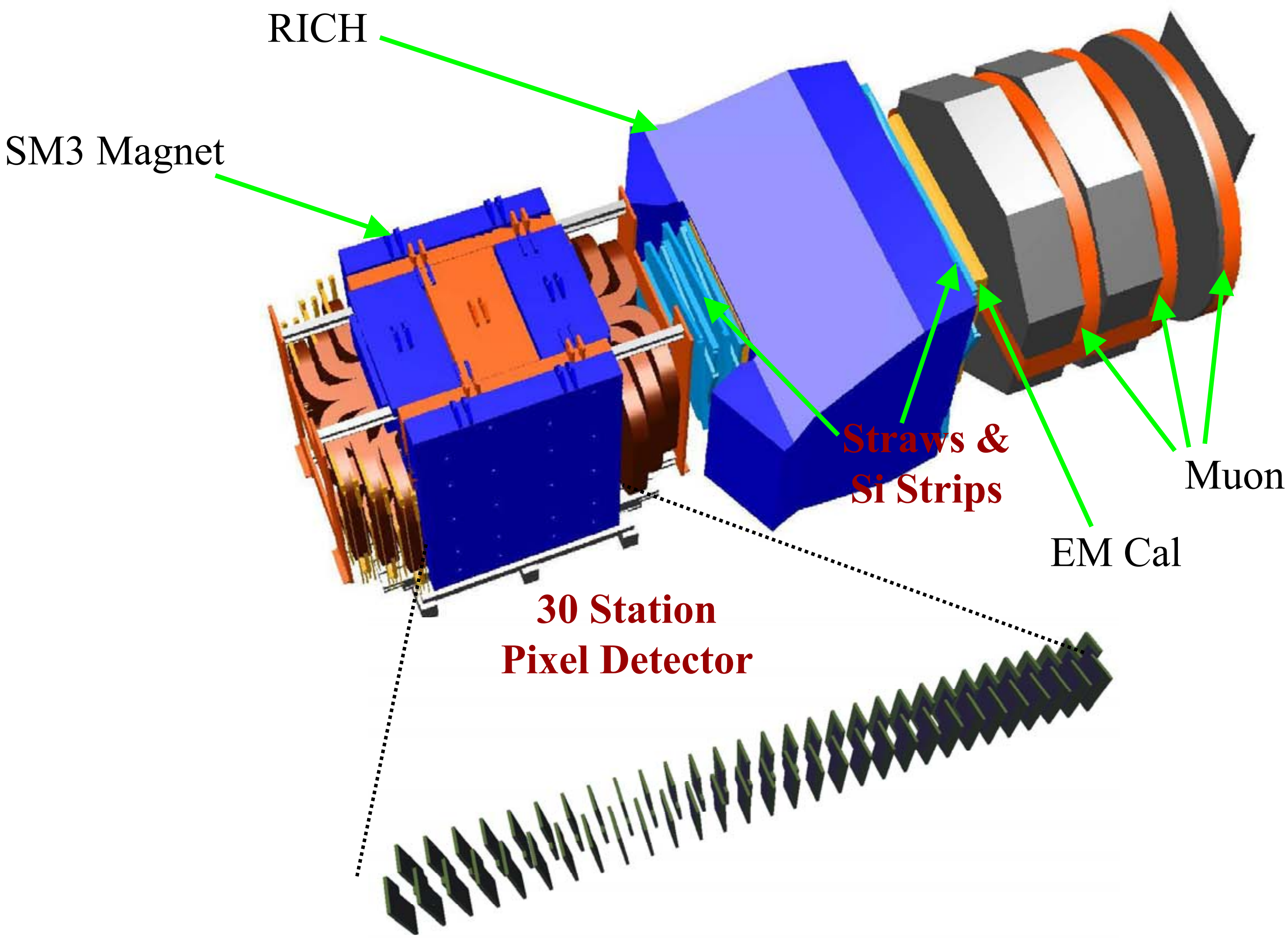
## Requirements

- **Coverage**:
  - Aperture 300 mr
  - Momentum acceptance 3 - >100 GeV/c
- **Tracking efficiency > 98%**
- **Resolution for vertex detector:**
  - Spatial : < 9 μm
  - Time: < 50 fs
- **Vertex detector info available for use in L1 trigger**
- **Angular resolution**:
  - Better than 0.1 mr
- **Momentum resolution**:
  - 1% at 100 GeV/c
- **Can handle huge data rate and survive high radiation dosage**

## Key features

- **Vertex Detector**
  - **Pixel Detector (WBS1.2)**
    - Precise vertex detection and reasonable momentum measurement capability
    - Fast info available for use in L1 vertex trigger
- **Forward Tracker**
  - **Straw (WBS1.6) and Silicon Strip (WBS1.7)**
    - Precise momentum measurement, Ks/Λ detection, project tracks into RICH, EMCAL, Muon chambers
    - Combination of **Silicon strips** near the beam and **Straw Chambers** at large radius

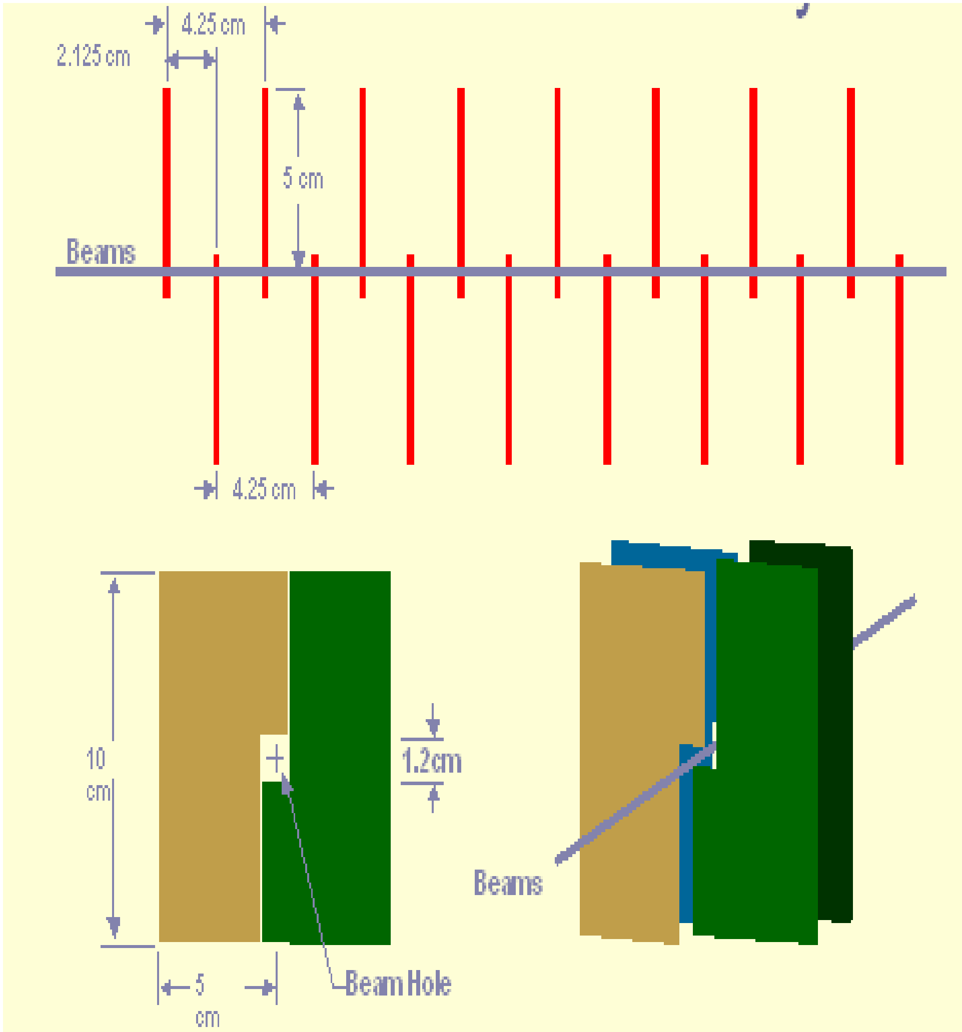
# BTeV Detector



# Technical Description of Pixel Detector WBS1.2

**Reasons for Pixel Detector:**
- Superior signal to noise
- Radiation Hard
- Excellent spatial resolution: <9 μm for all tracks
- Pattern recognition power
- Very low occupancy

**Special features:**
- Info used directly in the L1 trigger
- Placed inside a dipole and gives standalone momentum measurement
- Sitting close to beam and be retractable during beam refill -> needs vacuum system and rf shielding
- 30 stations with 23 million pixels in total
- Total length ~1.3m

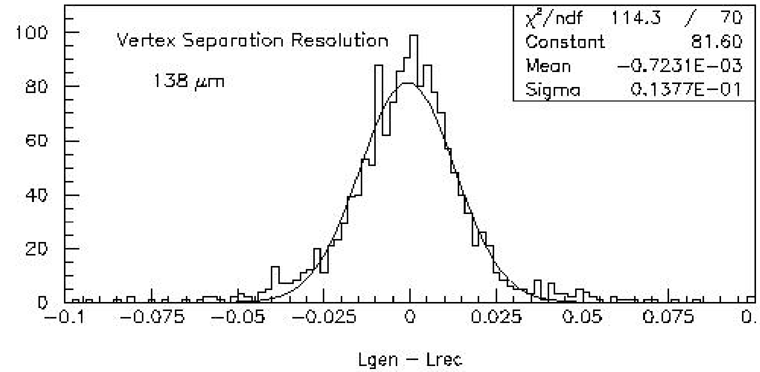


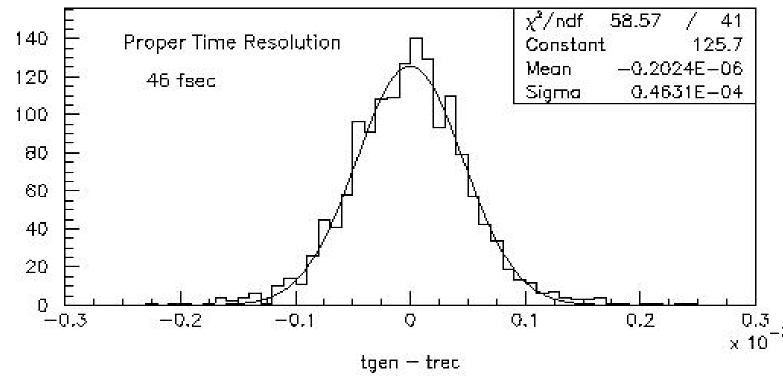
# Pixel Detector Properties & Performance WBS1.2

| Property | Value |
|---|---|
| Pixel Size | 50 μm x 400 μm |
| Outer plane dimension | 10 cm x 10 cm |
| Central square hole (adjustable) | Nominal setting: 12 mm x 12 mm |
| Number of planes | 60 |
| Number of stations | 30 |
| Number of pixels | 23 million |
| Total Silicon active area | 0.5 $m^2$ |
| Separation of stations | 4.25 cm |

## $B_s \rightarrow D_s\ K^+$

**Primary-secondary vertex separation**
**Reconst - generated.** $\sigma = 138\mu$




$\tau_{proper}$ (reconstructed) - $\tau_{proper}$ (generated)
$\sigma = 46$ fsec

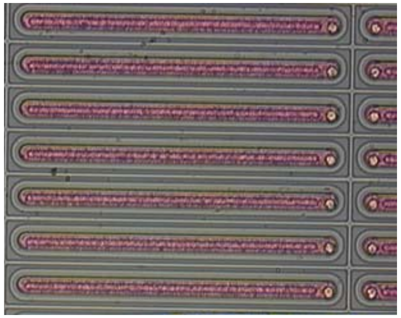
# Pixel Components WBS 1.2

- WBS 1.2.1: Sensor & Detector Hybridization
  - Includes design, procurement and testing of sensor wafers, flip-chip mating of sensors to readout chips to get pixel modules
- WBS 1.2.2: Electronics
  - Includes pixel readout chips, data cables, PIFC, Feed-through Board (FTB), HV/LV power supplies and cables
- WBS 1.2.3: Mechanical & Vacuum system
  - Includes substrate, fixtures, vacuum vessel, position control system, cooling system, vacuum system, support structure, and rf shield
- WBS 1.2.4: System Integration
  - Includes production HDI, pixel module assembly and testing, test-stands, station assembly, detector assembly, beam test, control &monitoring, fast interlocks, system test, system software
- WBS 1.2.5: Project Management

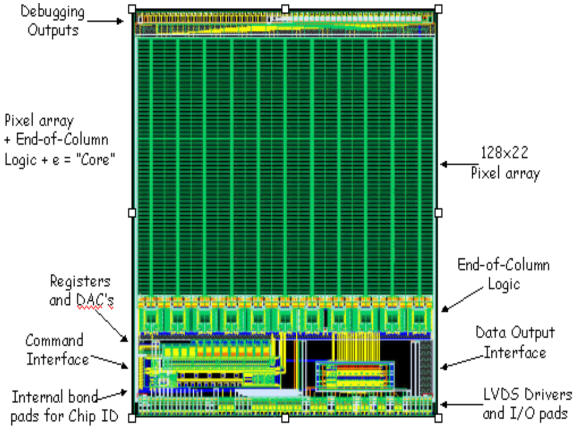
# Pixel Detector WBS 1.2

- Pixel Sensor bump-bonded to Readout chip
- Fine segmentation
  - 50 µm x 400 µm
  - Large number of channels
  - Electronics in the active tracking volume
  - High power density (~ 3kW -> cooling system)
- Basic building block – Multichip Module (MCM)
  - 4 types (4, 5, 6, and 8 chip array)
  - Large number of HDI and flex cables
- Assemble modules on both sides of substrate to form pixel half plane; an x-measuring half-plane and a y-measuring half-plane form a half-station

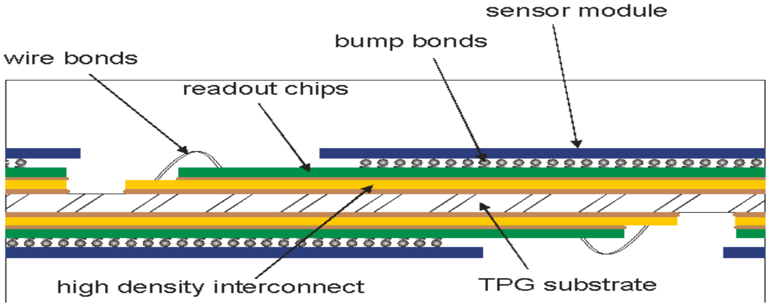
**Si pixel sensors**



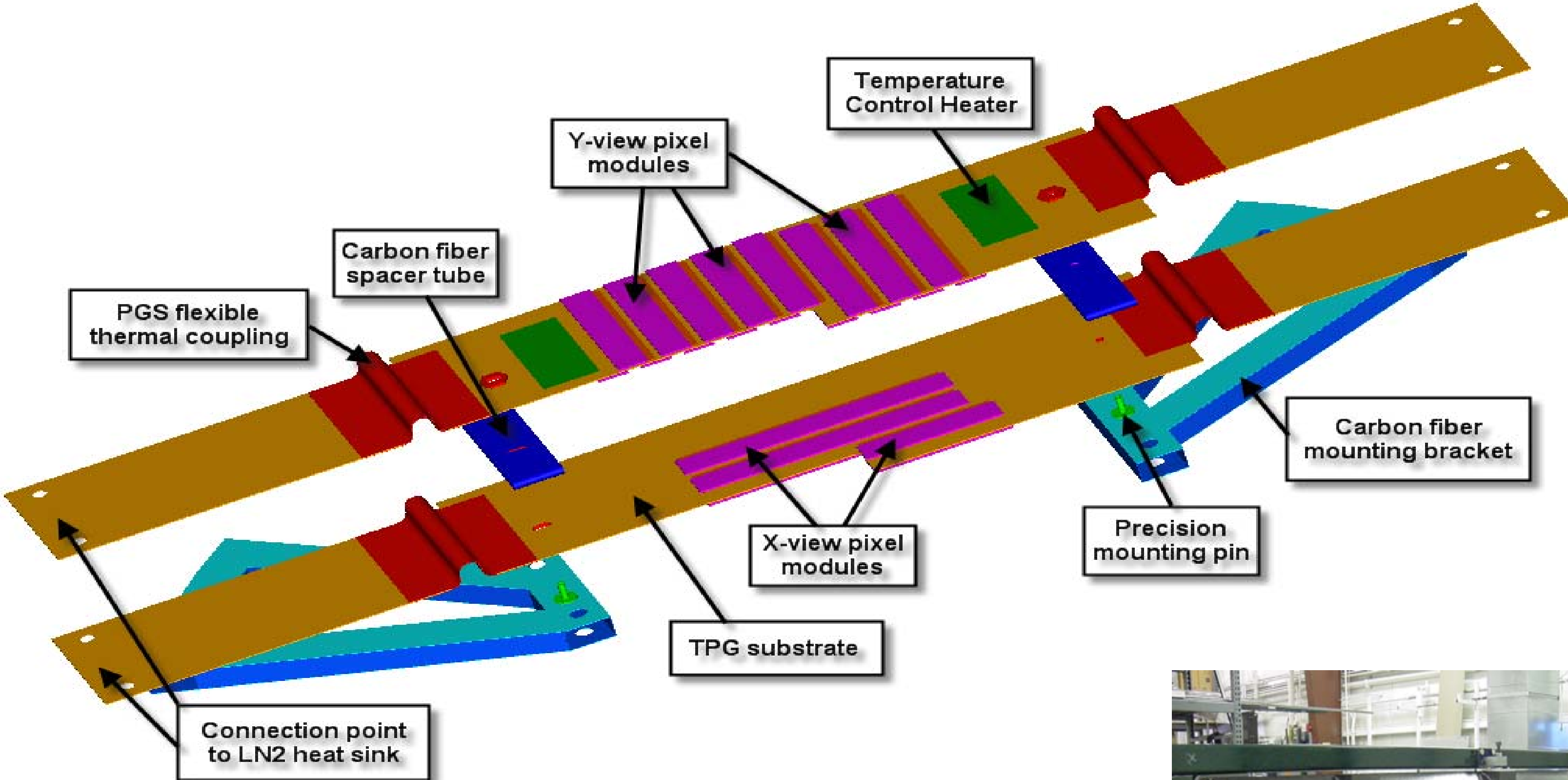
**Pixel Readout chip**



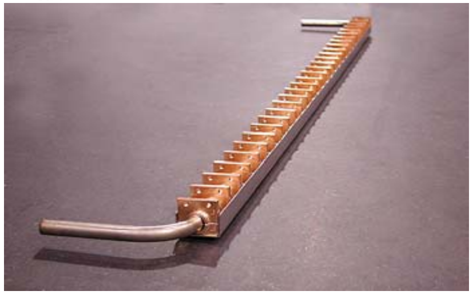

**Multichip module**



# Pixel Half-Station WBS1.2

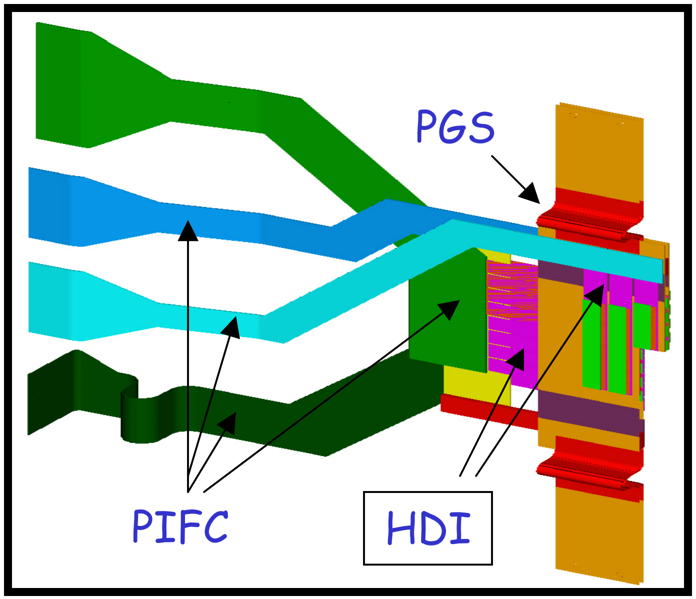



Cu tabs brazed to SS tube-$LN_2$ heat sink

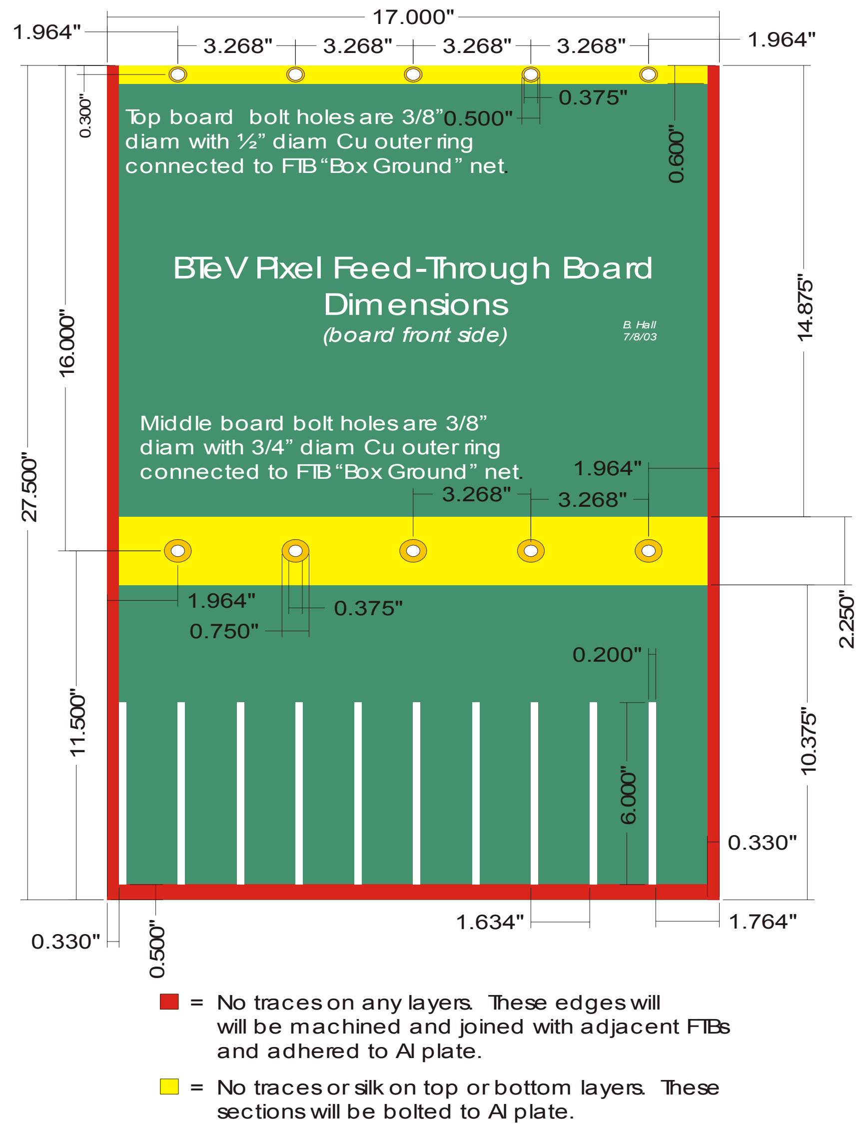


Carbon support half cylinder (~1.26m long)

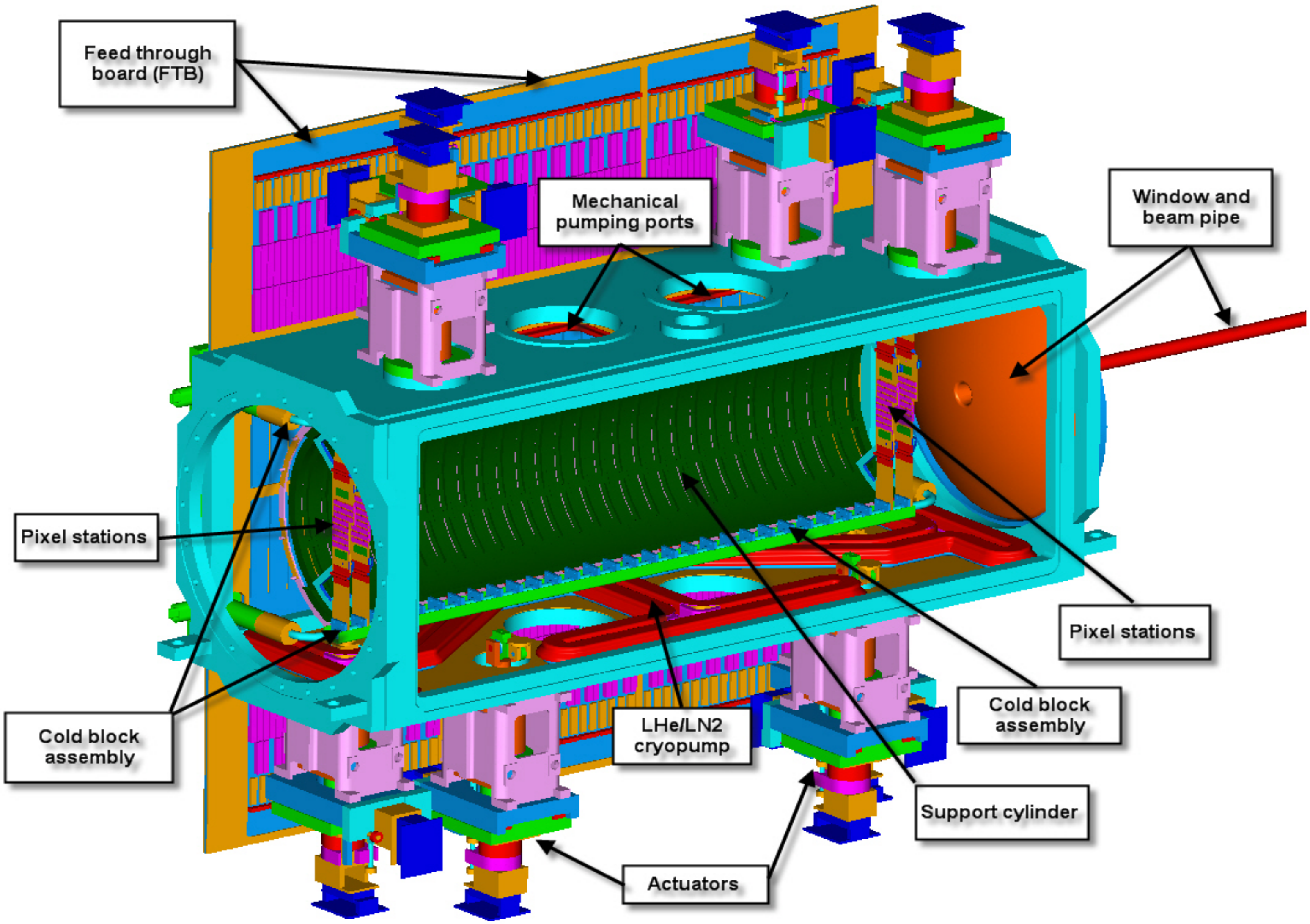
# Feed-through Board (FTB) WBS1.2




- Signal path: ROC- HDI- PIFC- FTB- PDCB-trigger/DAQ system
- Board size: 17”x27.5”; more than 16 layers
- Full size FTB prototype will be delivered next month
- Key for mechanical and electrical tests
- FTB layout is very dense and can benefit from any possible simplification



# Pixel Detector Assembly



# Pixel Detector Participants WBS 1.2

**Fermilab:** J. A. Appel, D. C. Christian, S. Cihangir, J. Fast, R. Kutschke, S. Kwan, M. Marinelli, L. Uplegger, J. Andresen, M. Bowden, G. Cardoso, H. Cease, C. Gingu, J. Hoff, A. Mekkaoui, M. Turqueti, R. Yarema, J. Howell, C. Kendziora, M. Kozlovsky, M. Larwill, C.M. Lei, A. Shenai, M.L. Wong , S. Austin, S.Jakubowski, R. Jones, G. Sellberg, M. Ruschman, J. Rausch, R. Sanders, E. Skup

**Frascati:** S. Bianco, F. Fabbri, M. Caponero, D. Colonna, A. Paolozzi

**Iowa:** C. Newsom, M. Divoky, J. Morgan

**Milano:** G. Alimonti, S. Magni, D. Menasce, L. Moroni, D. Pedrini, S. Sala

**Syracuse:** M. Artuso, C. Boulahouache, J.C. Wang

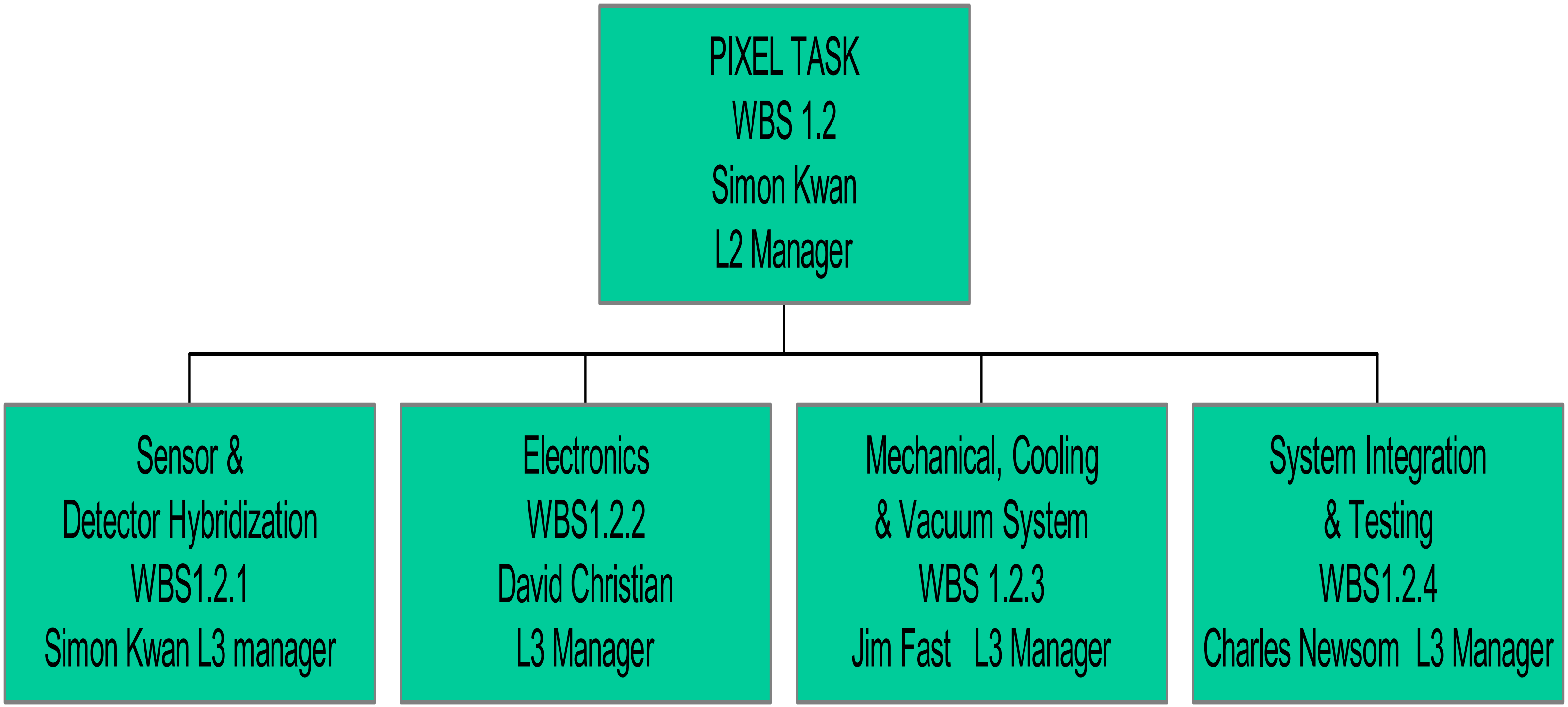
**Tennessee** T. Handler, R.Mitchell, S. Berridge

**Wayne State:** D. Cinabro, G. Bonvicini, A. Schreiner, A. Guiterrez, G. Gallay, S. LaPointe

-Physicist

- Technical staff

# Pixel L2 & L3 Managers WBS1.2



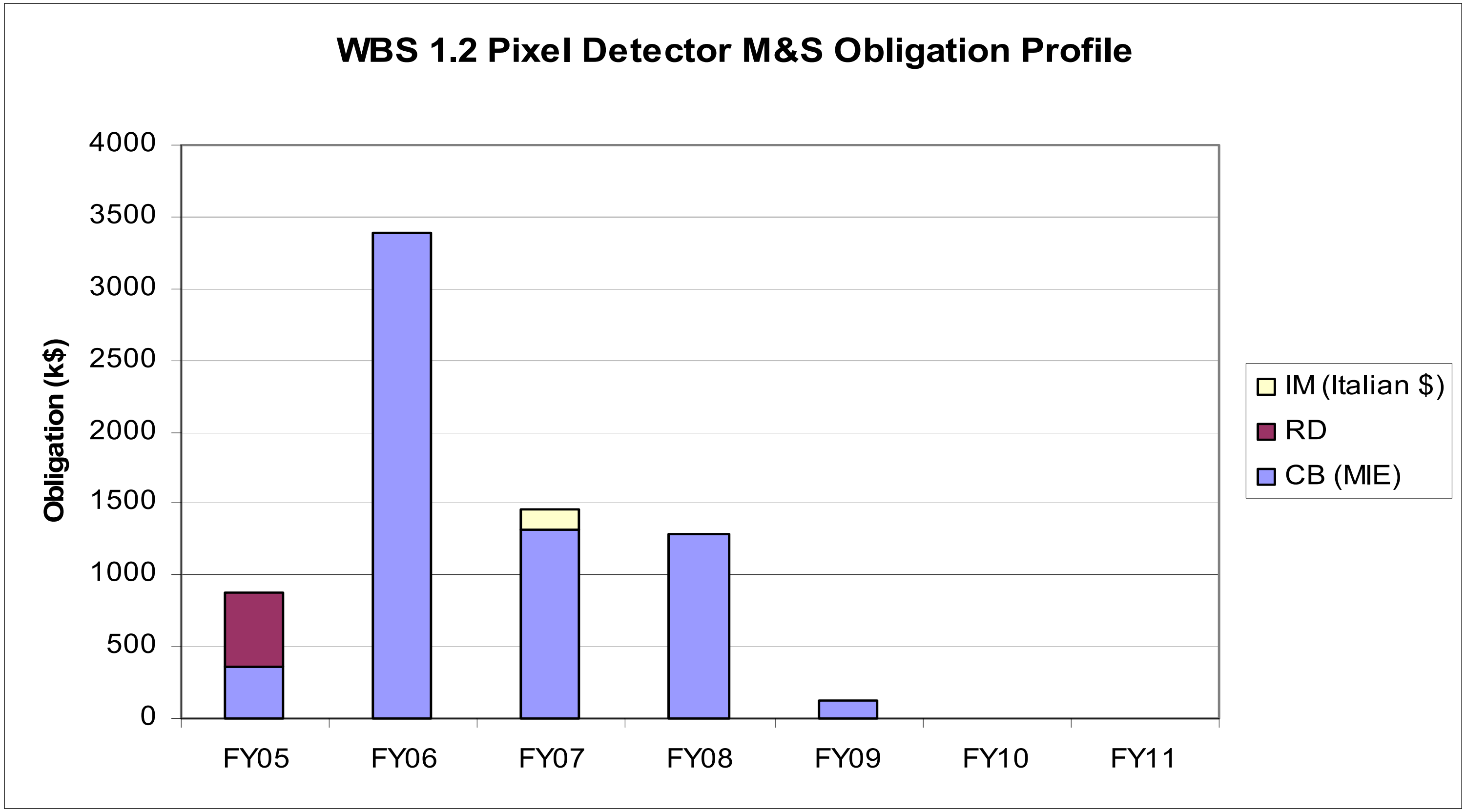

Base cost: $14.57M (Material: $7.14M, Labor: $7.43M)

# Pixel Construction Cost WBS 1.2

| Activity ID | Activity Name | Base Cost ($) | Material Contingency (%) | Labor Contingency (%) | Total FY05 | Total FY06 | Total FY07 | Total FY08 | Total FY09 | Total FY10 | Total FY05-10 |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 1.2.1 | Sensors and Pixel Detector Hybridization | 2,277,593 | 47 | 32 | 463,135 | 1,689,904 | 1,149,138 | 0 | 0 | 0 | 3,302,177 |
| 1.2.2 | Pixel Detector Electronics | 3,728,580 | 38 | 40 | 839,433 | 1,652,929 | 611,864 | 1,966,818 | 99,198 | 0 | 5,170,242 |
| 1.2.3 | Mechanical Cooling and Vacuum System | 4,163,408 | 48 | 38 | 617,761 | 2,413,926 | 1,578,080 | 1,304,943 | 0 | 0 | 5,914,710 |
| 1.2.4 | System Integration & Testing | 3,538,862 | 54 | 52 | 405,261 | 1,146,831 | 2,371,276 | 1,118,661 | 335,725 | 0 | 5,377,754 |
| 1.2.5 | Pixel Detector Subproject Management | 861,432 | 25 | 18 | 222,568 | 240,281 | 190,185 | 190,185 | 181,504 | 0 | 1,024,723 |
| | | | | | | | | | | | |
| 1.2 | file_12_092004 | 14,569,875 | 44 | 41 | 2,548,158 | 7,143,872 | 5,900,544 | 4,580,606 | 616,427 | 0 | 20,789,607 |

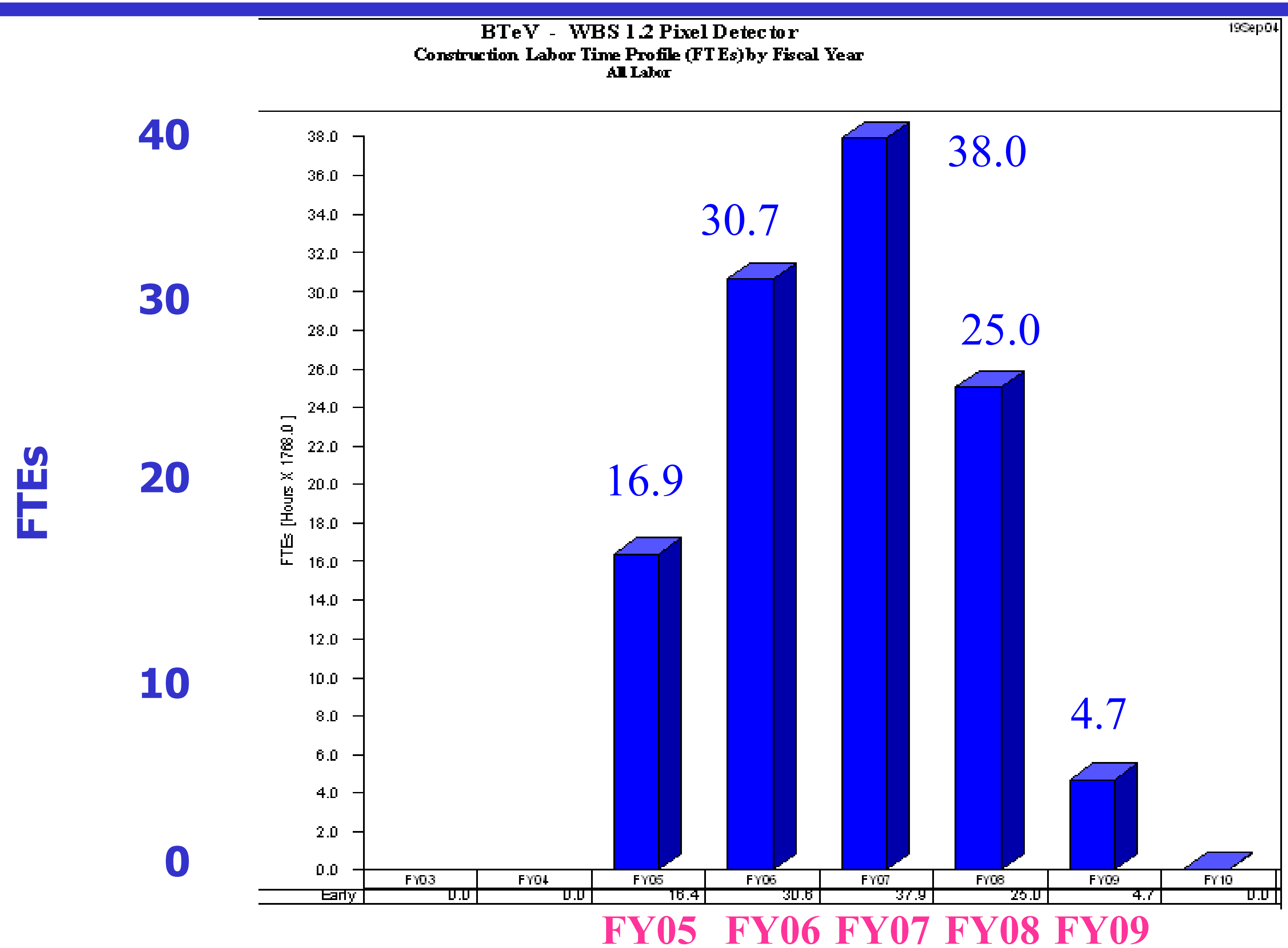
- CD1 Review: Base $15.5M Total $21.65M (contingency ~ 40%)
- Move DCB to WBS1.9 + new quotes (e.g. readout chips, TPG) reduce base M&S by $900K
- Increase labor and contingency (now 42.7%) following the CD1 reviewers' remark

# M&S Obligation Profile by Fiscal Year WBS 1.2



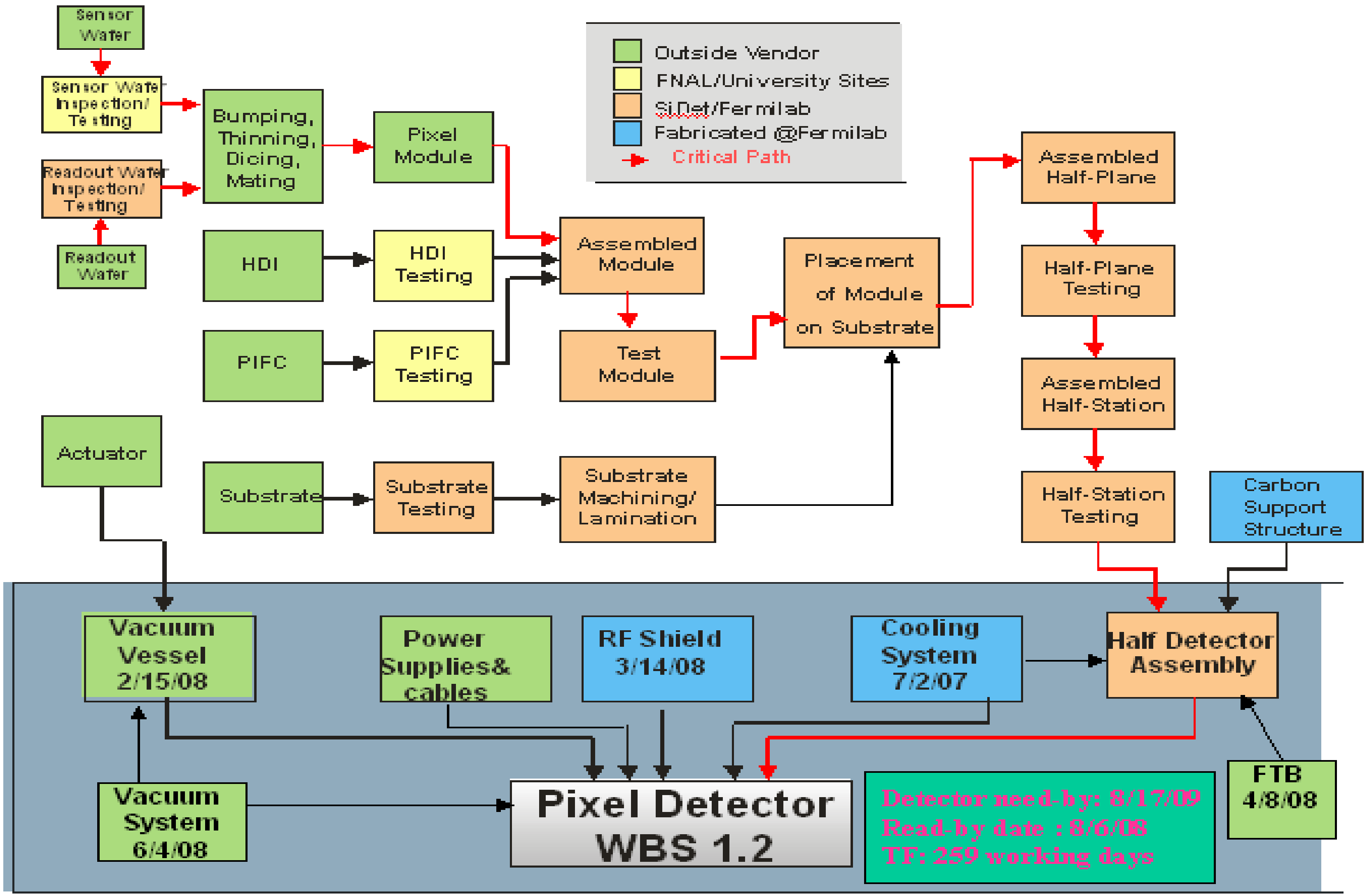

| | FY05 | FY06 | FY07 | FY08 | FY09 |
|---|---|---|---|---|---|
| CB (MIE) | 355 | 3393 | 1322 | 1286 | 126 |
| RD | 517 | | | | |
| IM (Italian $) | | | 143 | | |

# Labor Profile by Fiscal Year WBS 1.2



# Pixel Flow Diagram



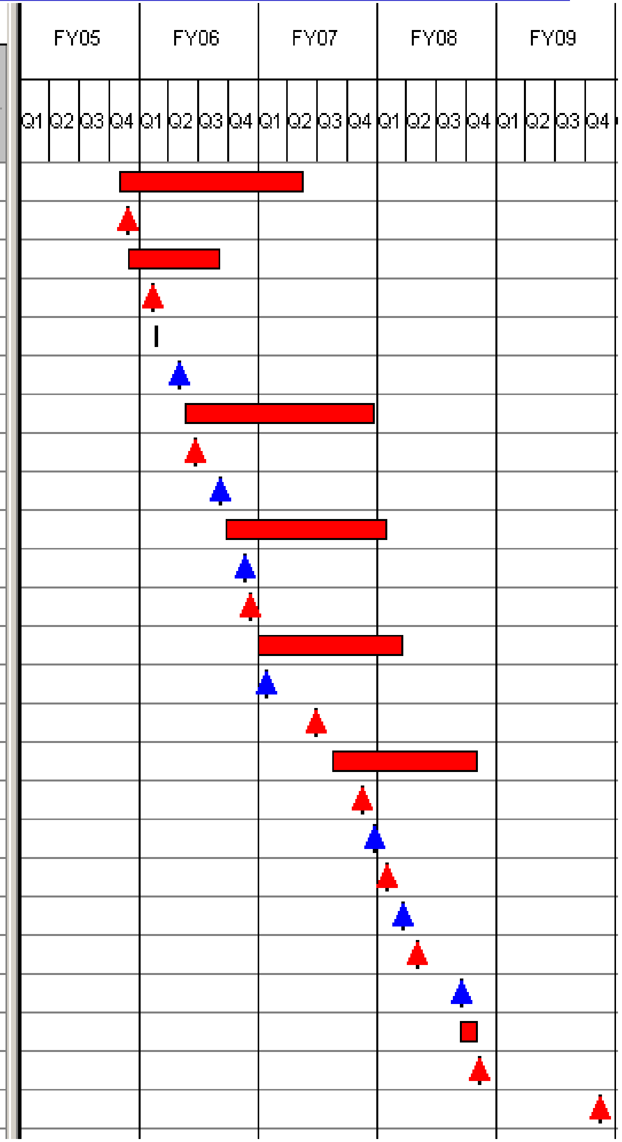


# Critical Path Analysis WBS 1.2

- **Detector need-by date: August 17, 2009**
- Scheduled completion date: August 6, 2008 giving a total float of **259** working days
- Pixel Detector will be installed as one piece (vessel with stations inside)
- Pixel Detector has many components but the critical path is the making the pixel modules, placing them on a substrate (half-plane and half-station), and assemble the half-stations into the two half-detectors. This is a sequence of production, assembly and testing steps. Because we have 1380 modules in total, the duration of the each sequence is long (10 months or more). To keep this tight schedule,
  - A lot of staggering in the activities
  - Place the orders early (sensor, ROC, hybridization)
    - DOE CD1 Report: advance the critical component procurement in 2005
  - Multiple paths/vendors
  - Sustain the flow of parts and have more than one assembly/test line/shift
  - Engage qualified vendors early in QA and throughput discussion

# Critical Path Gantt Chart WBS1.2

| WBS | Activity Desc. | Early Start | Early Finish | Total Float |
|---|---|---|---|---|
| 1.2.1.3.1 | Production Sensors - FNAL | 02Aug05 | 16Feb07 | 295d |
| 1.2.1.3.1.3.6 | T2M: Release funds for Production pixel sensors | 24Aug05 | 24Aug05 | 306d |
| 1.2.2.1.7 | PRC Production - FNAL | 29Aug05 | 07Jun06 | 264d |
| 1.2.2.1.7.8.3 | T2M: Release fund for production pixel ROC | 10Nov05 | 10Nov05 | 319d |
| 1.2.1.3.1.4.2.2 | Receive first batch of Production Sensors | 22Nov05 | 28Nov05 | 305d |
| 1.2.2.1.7.9 | T5M: Receive all FPIX wafers | 31Jan06 | 31Jan06 | 279d |
| 1.2.1.6 | Hybridization & Testing of Production Detectors | 24Feb06 | 20Sep07 | 262d |
| 1.2.1.6.1.2.2 | T2M:Release funds for production detector hybridization | 21Mar06 | 21Mar06 | 262d |
| 1.2.2.1.7.14 | T5M: Production PRC completely tested | 07Jun06 | 07Jun06 | 318d |
| 1.2.4.1.4.8 | Assembly and Test of PM | 28Jun06 | 29Oct07 | 262d |
| 1.2.1.6.1.2.7.2 | T5M: first lot of pixel detectors delivered | 21Aug06 | 21Aug06 | 337d |
| 1.2.1.3.1.6 | T4M: Production sensor wafers completely delivered & tested | 05Sep06 | 05Sep06 | 438d |
| 1.2.4.3.6 | Production pixel station assembly | 05Oct06 | 17Dec07 | 262d |
| 1.2.3.2.3.23 | T5M: all substrates ready for module placement | 24Oct06 | 24Oct06 | 496d |
| 1.2.4.3.6.2.8 | T2M: Final pixel detector station assembly started | 27Mar07 | 27Mar07 | 262d |
| 1.2.4.4.8 | Production pixel detector system assembly | 22May07 | 06Aug08 | 258d |
| 1.2.1.6.1.2.8 | T4M: Receive all Production pixel detectors | 13Aug07 | 13Aug07 | 268d |
| 1.2.1.6.5.4 | T5M: All Production pixel detectors delivered & tested | 20Sep07 | 20Sep07 | 262d |
| 1.2.4.1.4.10 | T2M: Production Pixel Module Completed | 31Oct07 | 31Oct07 | 263d |
| 1.2.4.3.6.8 | T5M: All pixel stations assembled | 17Dec07 | 17Dec07 | 269d |
| 1.2.4.3.7.6 | T4M: All pixel stations assembled & tested | 29Jan08 | 29Jan08 | 262d |
| 1.2.4.4.8.11 | T5M: Pixel detector fully assembled & ready for Test | 17Jun08 | 17Jun08 | 258d |
| 1.2.4.4.8.12 | Testing of the assembled detector at SIDET | 18Jun08 | 06Aug08 | 258d |
| 1.2.7.2.2 | T1M-6: Pixel System Tested/ Ready for Installation at C0 | 07Aug08 | 07Aug08 | 258d |
| 1.2.6.4.2.19 | Lk4M: Installation Need-by date for Pixel detector | 17Aug09 | 17Aug09 | 0 |



BTeV C0

# Key Milestones With Distributed Float



| Milestone | Date |
|---|---|
| T2M-3: Contract awarded for production pixel sensors | Nov 9, 2005 |
| T2M-2: Contract awarded for production pixel readout chips | Jan 24, 2006 |
| T1M-4: Contract awarded for production pixel detector hybridization | Jul 10, 2006 |
| T3M-13: Vacuum System designed & approved for construction | Jul 24, 2007 |
| T3M-14: Final pixel detector assembly started | Oct 12, 2007 |
| T3M-15 Pixel modules completed (assembly & testing) | Apr 11, 2008 |
| T1M-6: Pixel detector tested & ready to be shipped to C0 | May 9, 2009 |

Need-by Date: August 17, 2009

# Pixel Detector Risk Analysis WBS1.2

| Risks | Mitigation strategy |
|---|---|
| Bump bonding vendors not available or have unacceptable yield or throughput | Identify more vendors. Keep close contact with LHC experiments and have information about their schedule and vendors |
| Cannot achieve the vacuum required due to gas load much bigger than expected and we don't have enough space for larger pumps or cryopanels | Repeat outgassing test with a model which includes close to final components and full size FTB. Prototype the cryopumps |
| Pixel temperature control, cooling, and vacuum system do not work as designed. | We have put in our plan a system demonstrator program that will happen early in the construction phase to study this and various failure modes. |

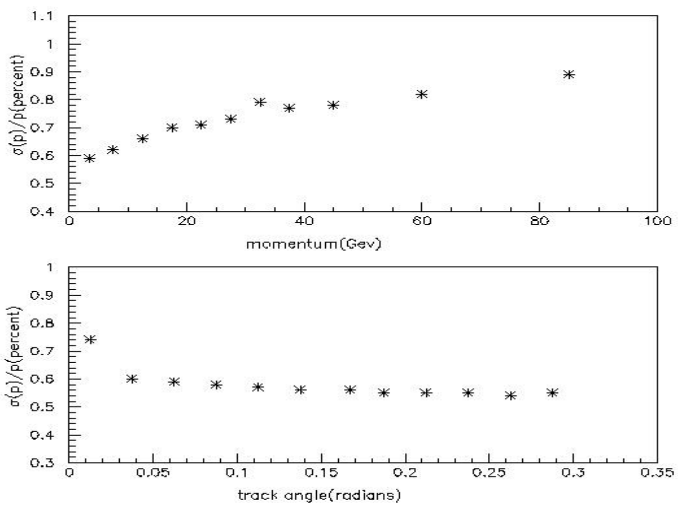
# Responses to CD1 recommendations WBS1.2

- Develop more conservative schedule with significant more float (> 6 months)
  - **We have followed their recommendation. By moving a few procurements forward and move back the detector need-by date, we have achieved a float of about 1 year.**
- Evaluating options for relaxing the funding profile constraints to achieve a more conservative approach
  - **DONE. We have increased the funding for FY05 to move up the production of sensors and speed up the module development.**
- Evaluate schedule and performance impact of staging options
  - **While we believe that the experiment will work with an efficiency of about 60% with say ½ of the pixel stations, to complete the installation of the other half of the pixel detector will lead to a long shutdown, estimated to be about 6 months or longer and with considerable risk to the forward tracking stations (which need to be removed first before the pixel vacuum vessel can be taken out). After careful consideration, we think that it's better to assign resources to guarantee the completion of the pixel detector on schedule and not pursue the staging option.**

# Technical Description of Straw Tracker WBS1.6

- **Straws: chosen because of of small cell size (segmentation)**
- **Uses Atlas design as basis**
- **0.8% Xo per station**
- **Tracking resolution: 150μm/view**
- **Momentum resolution better than 1% over full momentum and angle range**

| | |
|---|---|
| Straw size | 4 mm, 8mm diameter |
| Central dead region | 26 cm x 26 cm |
| Number of Stations | 7 |
| Z positions (cm) | 96, 138, 196, 288, 332, 382, 725 |
| Active Half size (cm) | 27.2, 40.8, 61.2, 88.4, 102, 115.6, 197.2 |
| Views per station | 3 |
| Layers per view | 3 |
| Total number of straws | 26784 |
| Total station thickness | 0.8% $X_0$ |
| Total channels | 53568 |
| Readout | ASDQ + TDC(8 bits), sparsified |




Momentum resolution

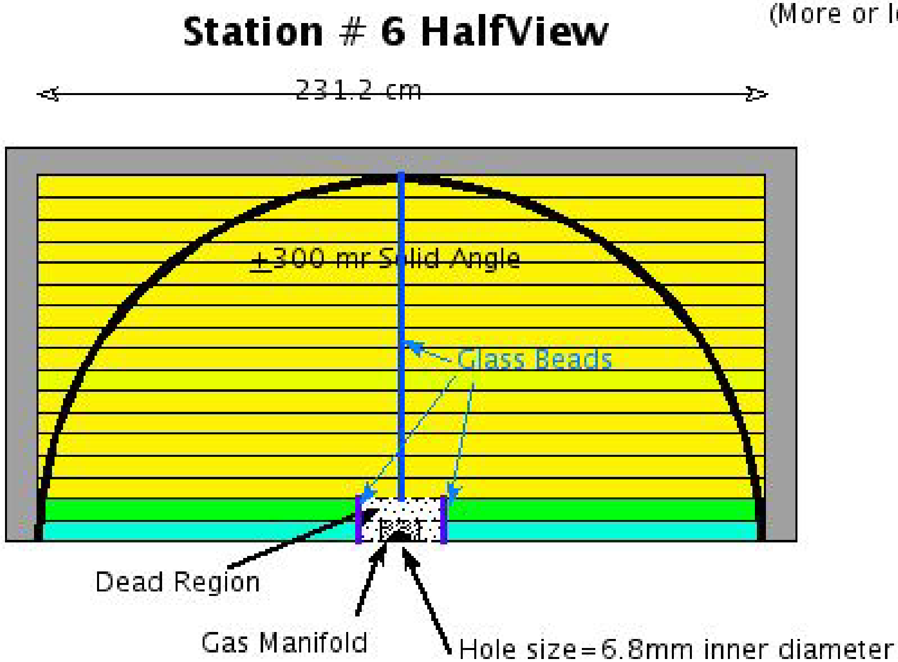
# Straw Components WBS 1.6

- 1.6.1 - Straw Detectors (7 stations)
  - the physical Detector.
- 1.6.2 - Straw Electronics-
  - includes front-end electronics, High and Low Voltage power supplies and cables.
- 1.6.3 - “Other” Mechanical Subsystems
  - Gas system, temperature control…
- 1.6.4 - Hardware and Software specific to Straw Detector
  - Test Stations with database connections
  - Fast Interlocks and Slow Controls
- 1.6.5 - Management

Base cost: $10.0M (Material: $5.0M, Labor: $5.0M)

# Straw Detector – "half-view" WBS1.6

(More or less to scale)




Assembled in groups of 48 straws - Modules

17 modules/HalfView
Mod type 1=96 straws (short straw)
Mod type 2=48 straws
Mod type 3=720 straws

**total=864 straws**

Mod type 1 (96 4mm diameter Straws, gas Manifold and 27 cm dead region)

Mod type 2 (48 4mm diameter Straws, 27 cm dead region)

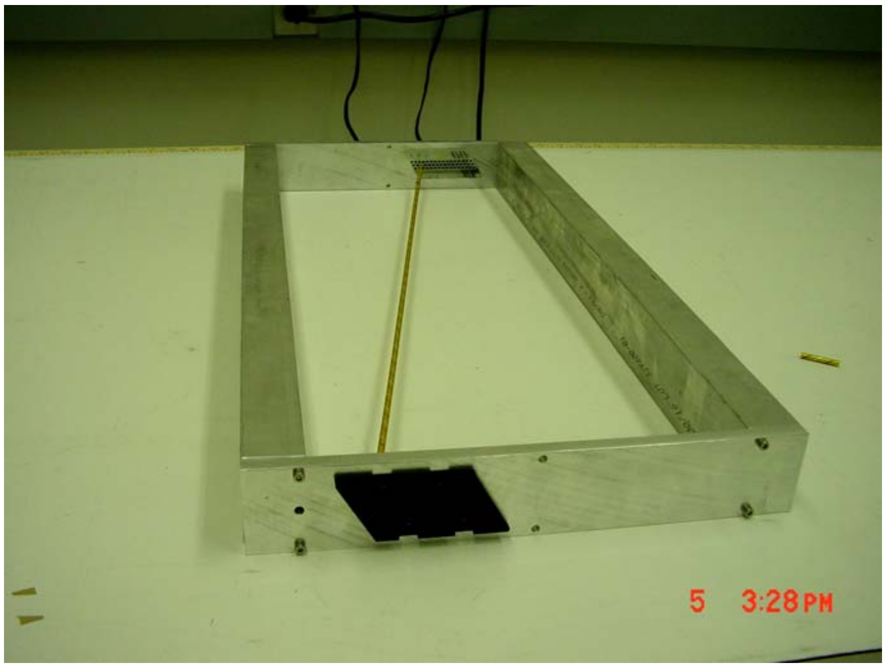
Mod type 3 (48 4mm diameter Straws)

4mm modules have 3 planes of 16 straws

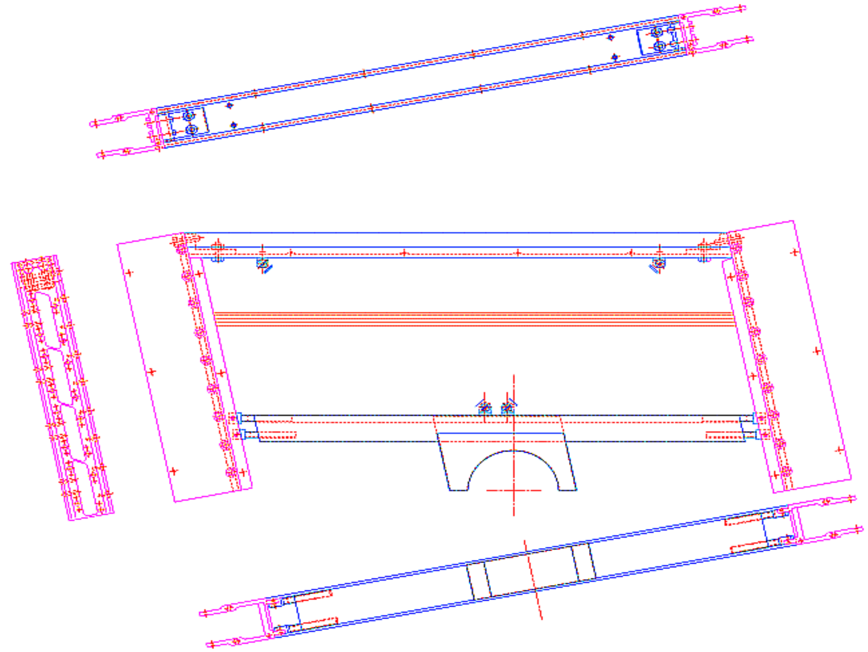
module is 6.8cm high (6.4 mm straws+2mm gap each side)

# Straw Detector Stations 1 & 2 WBS1.6

Straw Length =54 cm
384 Straws/View
1152 Straws/station

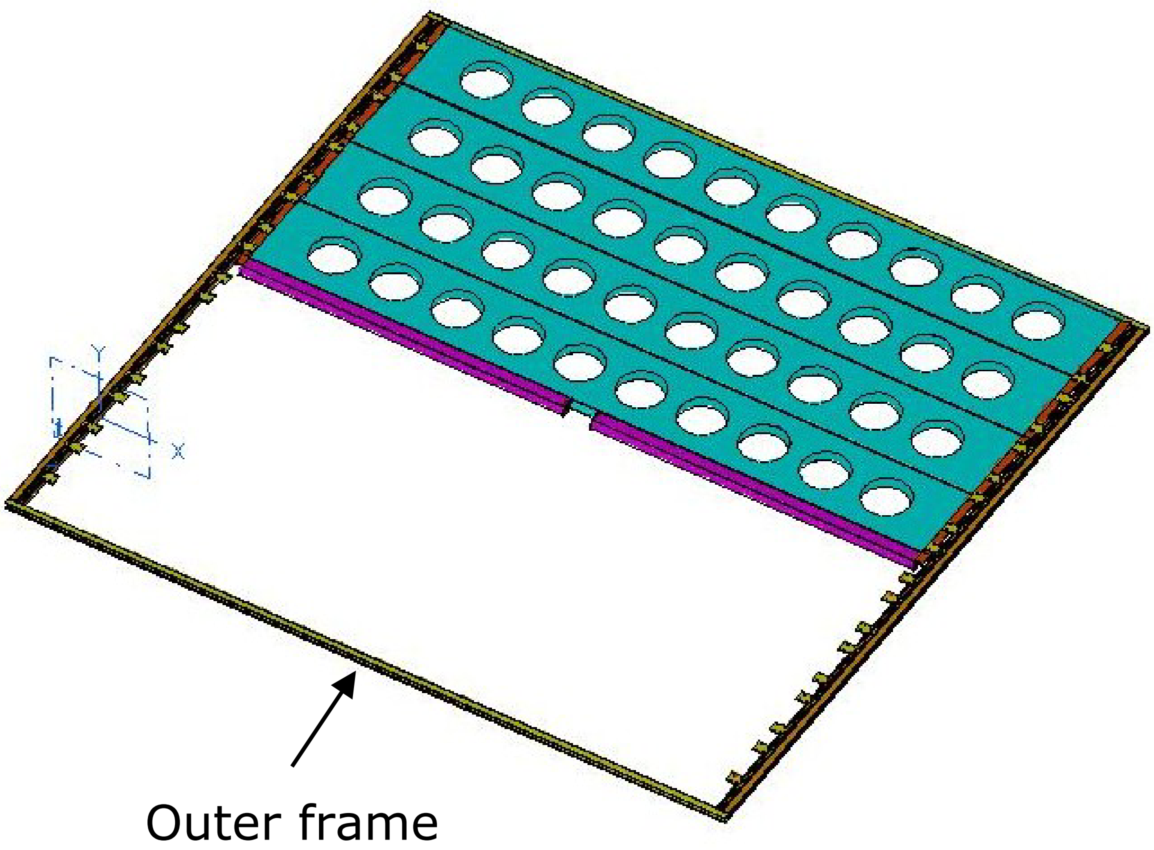



Station 1 "Prototype" Frame



Station #1 U,V HalfView Frame.
X View is simple rectangular shape

# Station 7 – View Outer Frame (One VIEW) WBS1.6



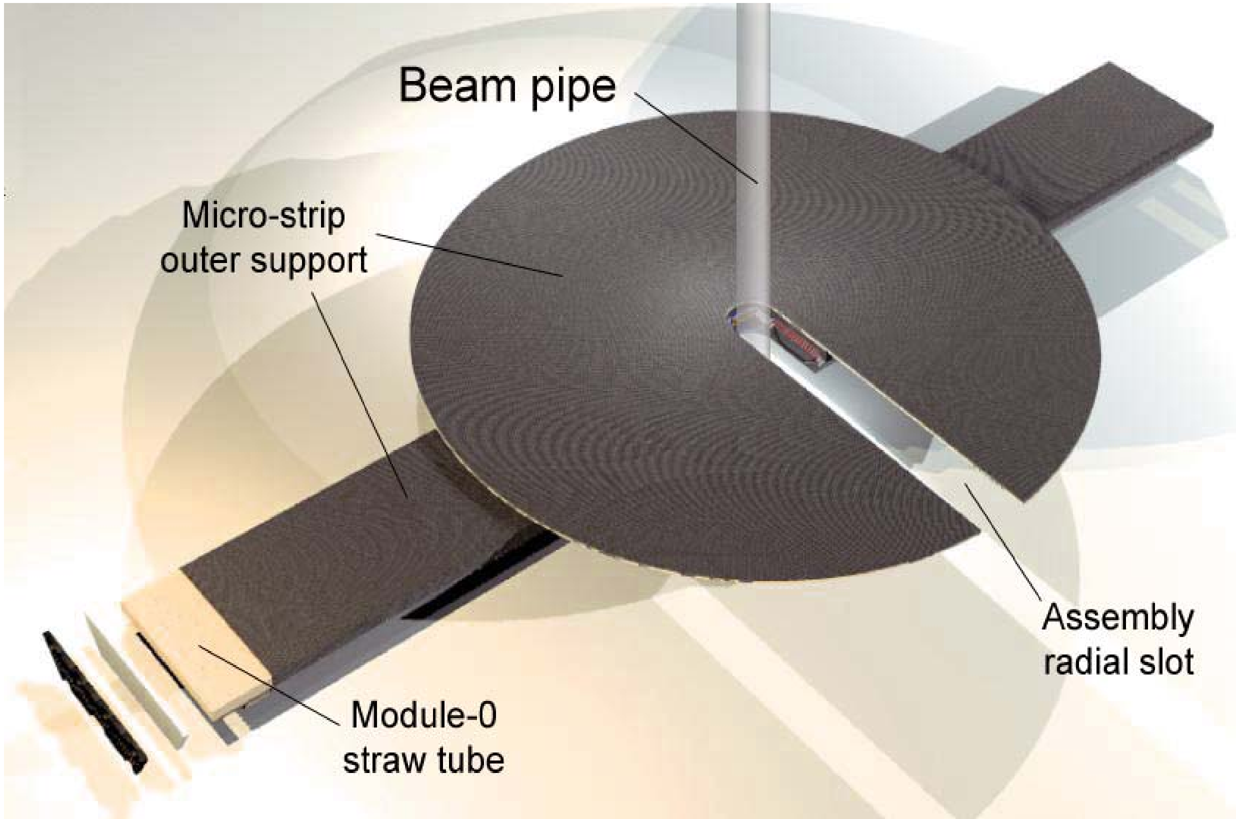

- Station 7 constructed of super-modules
- Super-module attached at ends to Outer Frame
- Outer Frame supports and aligns super-modules
- Each Outer frame supported individually from above by connecting rods

# Straw MOX module – Silicon Support WBS1.6

New Straw module designed at Frascati to support the forward Silicon stations. Replaces the 2 modules in X-view that surround the beam-pipe. Supported independently of Straw station

Straws are embedded in rohacell so no tension needed to keep them straight. Module has carbon fiber shell.

Carbon fiber disk is attached for Silicon support



# Straw Detector Participants WBS 1.6

- **Fermilab: A.A. Hahn, P. Kasper, H. Cease, J. Howell, J. Krider, A. Lee, D. Olis, T. Tope, W. Stuermer, C. Serritella, Z.Shi, D. Butler, B. Pritchard, Y. Orlov**
- **Frascati: F. Bellucci, M. Bertani, L. Benussi, S. Bianco, M. A. Caponero, F. Fabbri, F. Felli, M. Giardoni, G. Mensitieri, A. La Monaca, E. Pace, M. Pallotta, A. Paolozzi, B. Ortenzi**
- **Southern Methodist University: T. Coan, M. Hosack**
- **University of Houston: K. Lau, B. Mayes, G. Xu, S.Subramania, A. Daniel, M.Ispiryan**
- **University of Virginia: M. Arenton, S. Conetti, B. Cox, A. Ledovskoy, M.Ronquest, D. Smith, D. Phillips, H. Powell, W. Stephens**

-Physicist

-Grad Students

- Technical staff

# Straw Organization



**WBS 1.6**
**A. Hahn**

- **1.6.1** Straw Detectors — J. Krider — $6.0M
- **1.6.2** Straw Electronics — W. Stuermer — $2.2M
- **1.6.3** Other Mech. Subsytems — D. Olis — $733k
- **1.6.4** Integration & Testing — P.Kasper — $204k
- **1.6.5** Management — D.Olis ME, W.Stuermer EE, J. Krider PE — $923k

- **FNAL Site** — **A. Hahn**
- **Frascati Site** — **F. Fabbri**
- **U Houston Site** — **K.Lau**
- **SMU Site** — **T. Coan**
- **UVa Site** — **B. Cox**

Base cost: $10.0M (Material:$5.0M, Labor:$5.0M)

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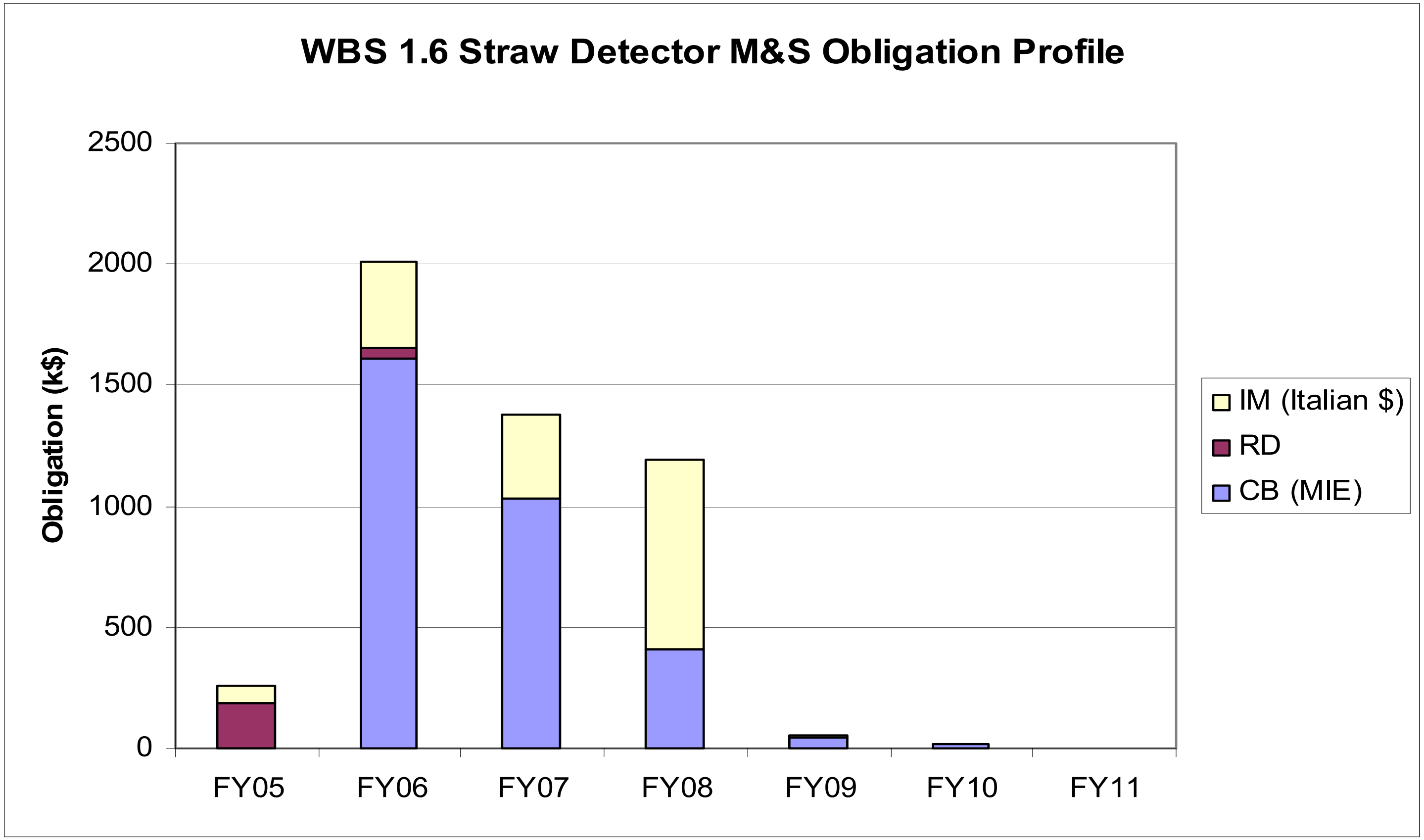
# Straw Tracker Construction Cost WBS 1.6

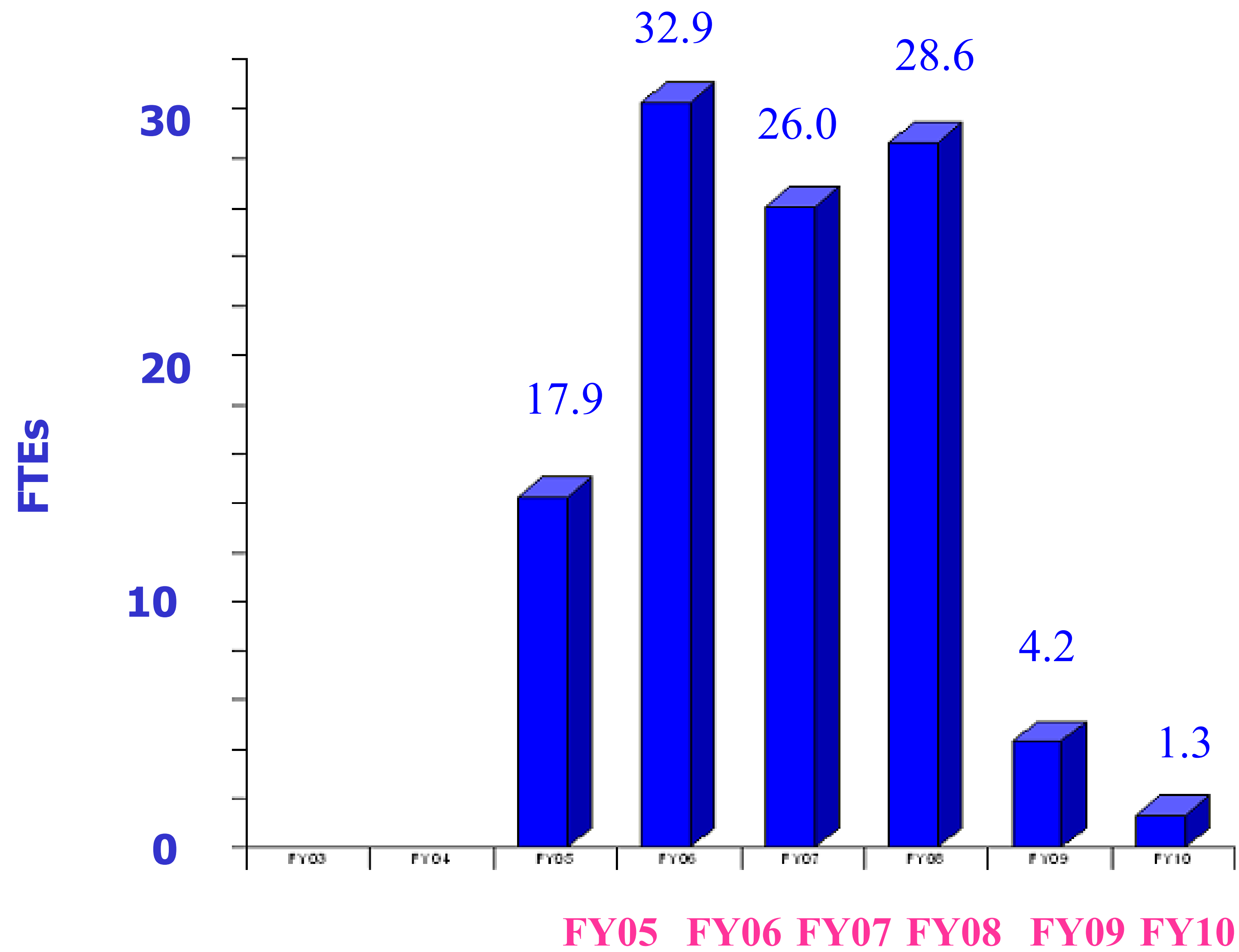
| Activity ID | Activity Name | Base Cost ($) | Material Contingency (%) | Labor Contingency (%) | Total FY05 | Total FY06 | Total FY07 | Total FY08 | Total FY09 | Total FY10 | Total FY05-10 |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 1.6.1 | Straw Chambers | 6,010,806 | 23 | 28 | 381,426 | 2,942,786 | 2,180,499 | 1,946,006 | 92,419 | 0 | 7,543,136 |
| 1.6.2 | Straw Detector Electronics | 2,168,546 | 27 | 36 | 456,470 | 894,403 | 985,464 | 486,232 | 8,652 | 0 | 2,831,221 |
| 1.6.3 | Mechanical Gas Calibration & Other Support Systems (FNAL SMU) | 733,011 | 30 | 37 | 40,769 | 199,303 | 170,646 | 553,044 | 18,213 | 0 | 981,975 |
| 1.6.4 | Integration & Testing (all) | 204,034 | 31 | 87 | 59,302 | 95,979 | 69,900 | 41,058 | 19,039 | 0 | 285,277 |
| 1.6.5 | Forward Tracker Straw Detector Subproject Management | 923,474 | 22 | 10 | 110,421 | 265,672 | 272,819 | 265,672 | 71,115 | 44,500 | 1,030,201 |
| | | | | | | | | | | | |
| 1.6 | file_16S_13Sep04 | 10,039,870 | 25 | 28 | 1,048,389 | 4,398,143 | 3,679,327 | 3,292,013 | 209,438 | 44,500 | 12,671,810 |

# M&S Obligation Profile by Fiscal Year WBS 1.6

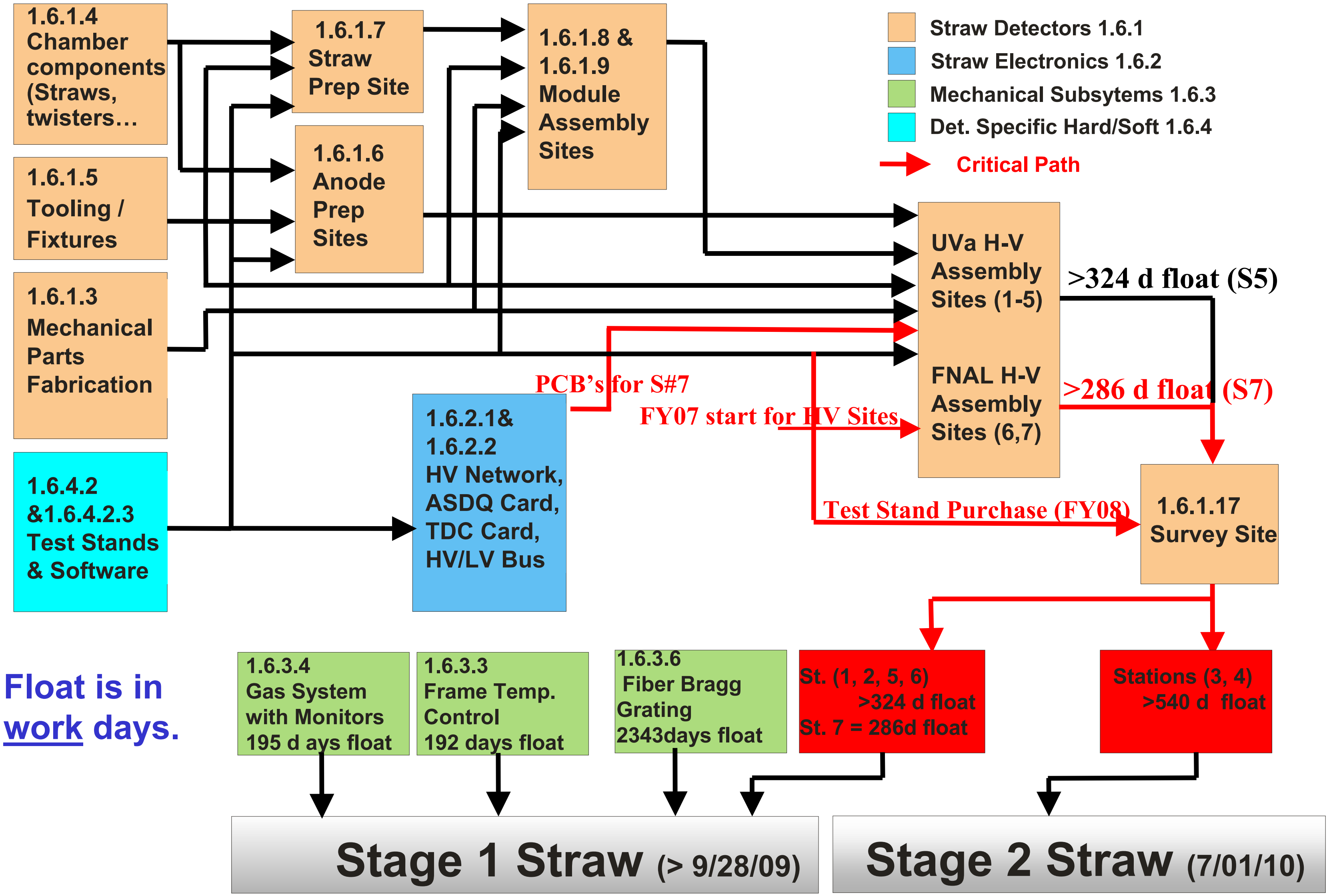



| | FY05 | FY06 | FY07 | FY08 | FY09 | FY10 |
|---|---|---|---|---|---|---|
| CB (MIE) | | 1613 | 1033 | 406 | 41 | 15 |
| RD | 184 | 42 | | | | |
| IM (Italian : | 77 | 356 | 349 | 783 | 8 | 0 |

# Labor Profile by Fiscal Year WBS 1.6



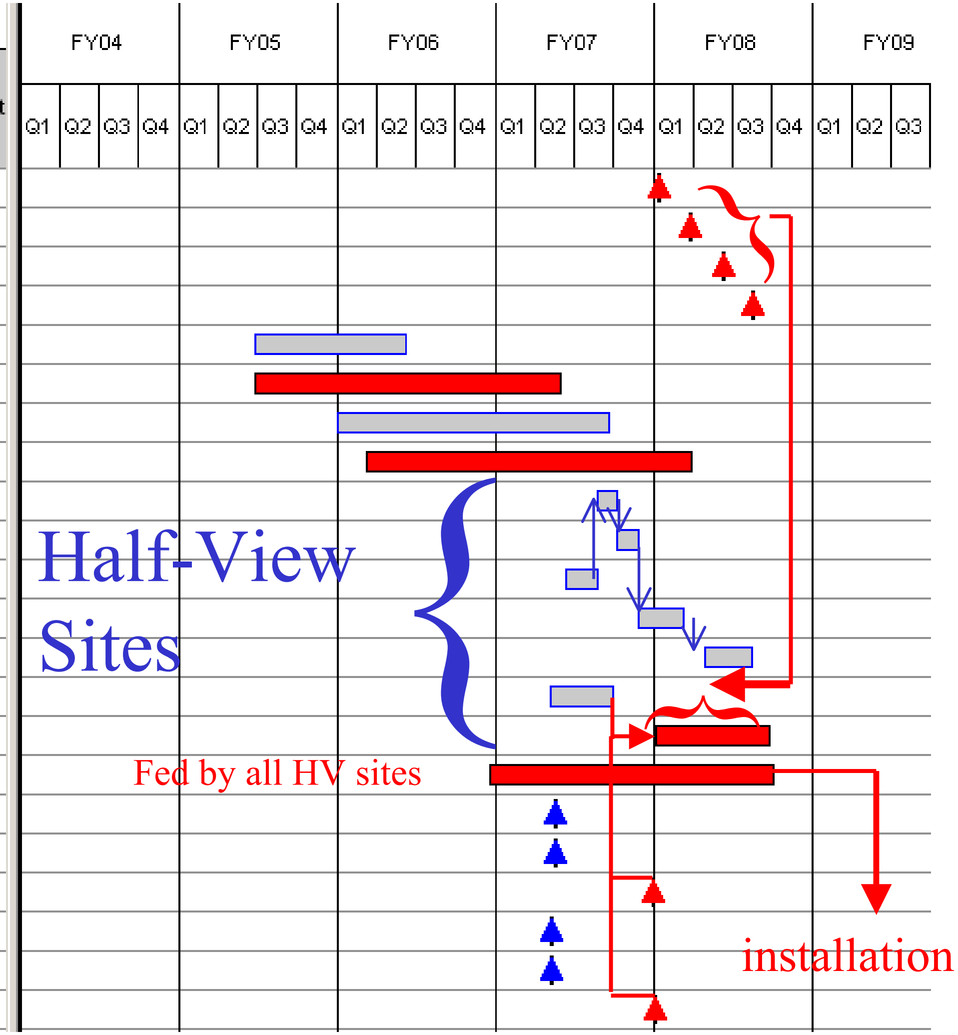
# Description of Straw Project Flow WBS 1.6




Float is in work days.

# WBS 1.6 Staged Gantt Chart

| WBS | Activity Desc. | Total Float |
|---|---|---|
| 1.6.1.3.3.3.2.16 | T5M: S#7 Supermodules Shells Ready, H-V1,2,3 | 358d |
| 1.6.1.3.3.3.2.17 | T5M:S#7 Supermodules Shells Ready, H-V 4 | 334d |
| 1.6.1.3.3.3.2.18 | T5M: S#7Supermodules Shells Ready,H-V 5 | 310d |
| 1.6.1.3.3.3.2.19 | T5M:S#7 Supermodules Shells Ready,H-V 6 | 286d |
| 1.6.1.4.1.2 | Straw Production Ordering -HOUSTON | 390.07d |
| 1.6.1.4.3.2 | Wire Centering Device Production Ordering - HOUSTON | 324.01d |
| 1.6.1.6 | Anode Wire Sites (UVa, SMU) | 239.80d |
| 1.6.1.7 | Straw Preparation Site (UH) | 324.01d |
| 1.6.1.10.1 | Straw Station #1 Half-View Assembly Site (UVa) | 353.62d |
| 1.6.1.10.2 | Straw Station #2 Half-View Assembly Site (UVa) | 353.62d |
| 1.6.1.10.3 | Straw Station #3 Half-View Assembly Site (UVa) | 353.62d |
| 1.6.1.10.4 | Straw Station #4 Half-View Assembly Site(UVa) | 353.62d |
| 1.6.1.10.5 | Straw Station #5 Half-View Assembly Site(UVa) | 324.01d |
| 1.6.1.10.6 | Straw Station #6 Half-View Assembly Site (FNAL) | 378.17d |
| 1.6.1.10.7.2 | Straw Station #7 Production - FNAL | 286d |
| 1.6.1.11 | Survey and Test Station Site (FNAL) | 286d |
| 1.6.2.2.1.3.18 | T5M: HV Network Card for S#3 | 369.84d |
| 1.6.2.2.1.3.21 | T5M: HV Network Card for S#6 | 378.17d |
| 1.6.2.2.1.3.22 | T5M: HV Network Card for S#7 | 314.80d |
| 1.6.2.2.2.4.18 | T5M: Preamp Board for S#3 | 376.84d |
| 1.6.2.2.2.4.21 | T5M: Preamp Boardfor S#6 | 385.17d |
| 1.6.2.2.2.4.22 | T5M: PDB for S#7 | 309.80d |



# Critical Path Analysis WBS 1.6

- Straw Stations ready for Installation
  - ➢ Critical path is primarily set by funding profile
    - FY05
      - – Continue Design Work
        - » Frames, Front End Electronics, TDC ASIC….
    - FY06
      - – Start major procurements

        Straws, Twisters, ASDQ's,…
      - – Start Anode, Straw, and Module Production Sites.
    - FY07
      - – Start Half View Assembly Sites
      - – Production of Front End Electronics
  - ➢ The current production scheme builds (S3,S4,S1,S2,S5) and (S6, S7) at two parallel Half View production sites.
    - The production time scales are set by various assumptions on assembly lines (2/site) and a single shift. These assumptions ( # sites, # assembly lines, # shifts, and order of station production) could be changed.

# Straw Level 3 Milestones + WBS1.6

| WBS1.6 | Forward Straw Tracker | Date |
|---|---|---|
| 1.6.7.4.1 | T3M-38:PO Awarded: Production ASDQ Chips * | October 10, 2005 |
| 1.6.7.4.2 | T3M-39:ASDQ Procurement completed | August 3, 2006 |
| 1.6.7.4.3 | T3M-40:Straw Preparation Site Functional | March 7, 2006 |
| 1.6.7.4.4 | T3M-41: Half-View Production/ Assembly Sites Functional | February 7, 2007 |
| 1.6.7.4.5 | T3M-42: Station 1 ready for Installation * | April 3, 2008 |
| 1.6.7.4.6 | T3M-43: Station 7 ready for Installation | August 26, 2008 |

* Also a Level 2 Milestone

\+ With distributed Float

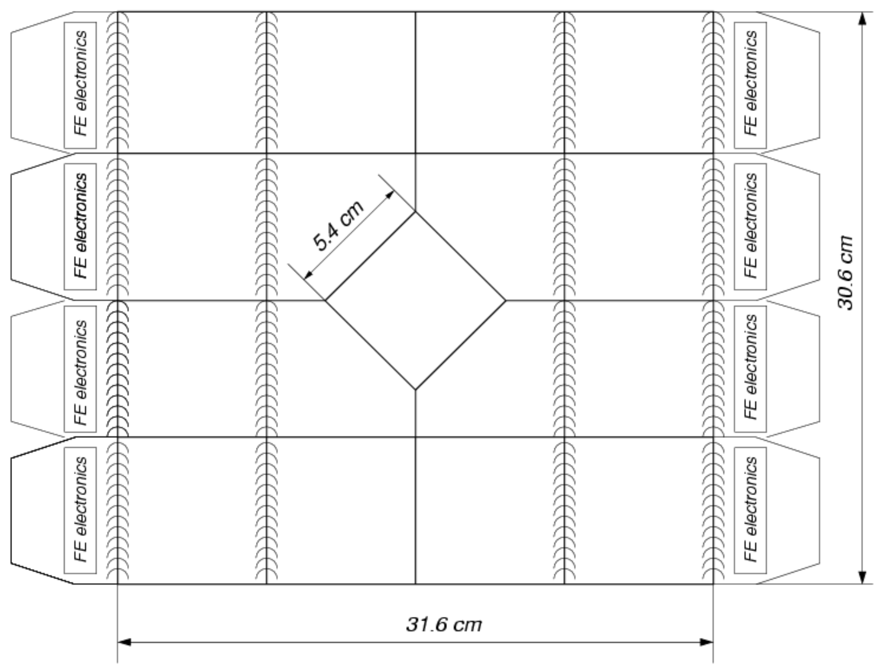
# Responses to CD1 recommendations WBS1.6

- Select the straw material, straw diameter, and wire diameter within this year. Clear work plan should be provided.
  - **We will acquire new Copperized Kapton Straws and subject them to radiation tests. We will also test 30 μm Anode wire (currently use 25 μm wire). We will set up a work plan.**
- Put Additional Effort into aging test
  - **UH and UVa will test new straw materials (and anodes) and UH, UVa, and SMU have proposal to undertake Rad Damage test at IUCF.**
- Produce more prototypes (preferentially in all production sites) and test. They should be built with production components and tooling as much as possible
  - **This is consistent with our Station 3 prototype effort**
- Move up production schedule by ~6 months
  - **DONE**
- Strengthen management with a project engineer
  - **Production engineer and site managers now added to the org. chart.**

# Technical Description of Silicon Tracker WBS1.7

- Silicon Strips: simple single sided $p^+/n$ design (CMS design)
- 7 stations
  - 3 in dipole fringe field
  - 3 before RICH
  - 1 after RICH
- Coverage from beam pipe to ±15.5cm from the beam
- Each station has 3 planes of 320 µm thick SMD with 100 µm pitch
- Each detector is 7.9 cm x 7.9 cm
- Four detectors form one ladder with readout at both ends
- New readout chip (FSSR) using 0.25µm CMOS; 1st prototype tested
- 2nd prototype submission planned for early next year

| Property | Value |
|---|---|
| Silicon Sensors | $\sim 7.9 \times 7.9\ cm^2$, $p$-on-$n$ type |
| Pitch | $100\ \mu m$ |
| Thickness | $320\ \mu m$ |
| Sensor configuration | 4 ladders with 4 sensors each |
| Coverage | $30.6 \times 31.6\ cm^2$ |
| Central Hole | $5.4 \times 5.4\ cm^2$ ($7 \times 7\ cm^2$ for last station) |
| Total Stations | 7 |
| Z Positions | 85.5, 127.5, 185.5, 277.5, 321.5, 371.5, 714.5 |
| Views per Station | 3 (X,U,V) |
| Channels per view | 6, 144 |
| Total Channels | 129, 024 |
| Readout | Sparsified Binary |



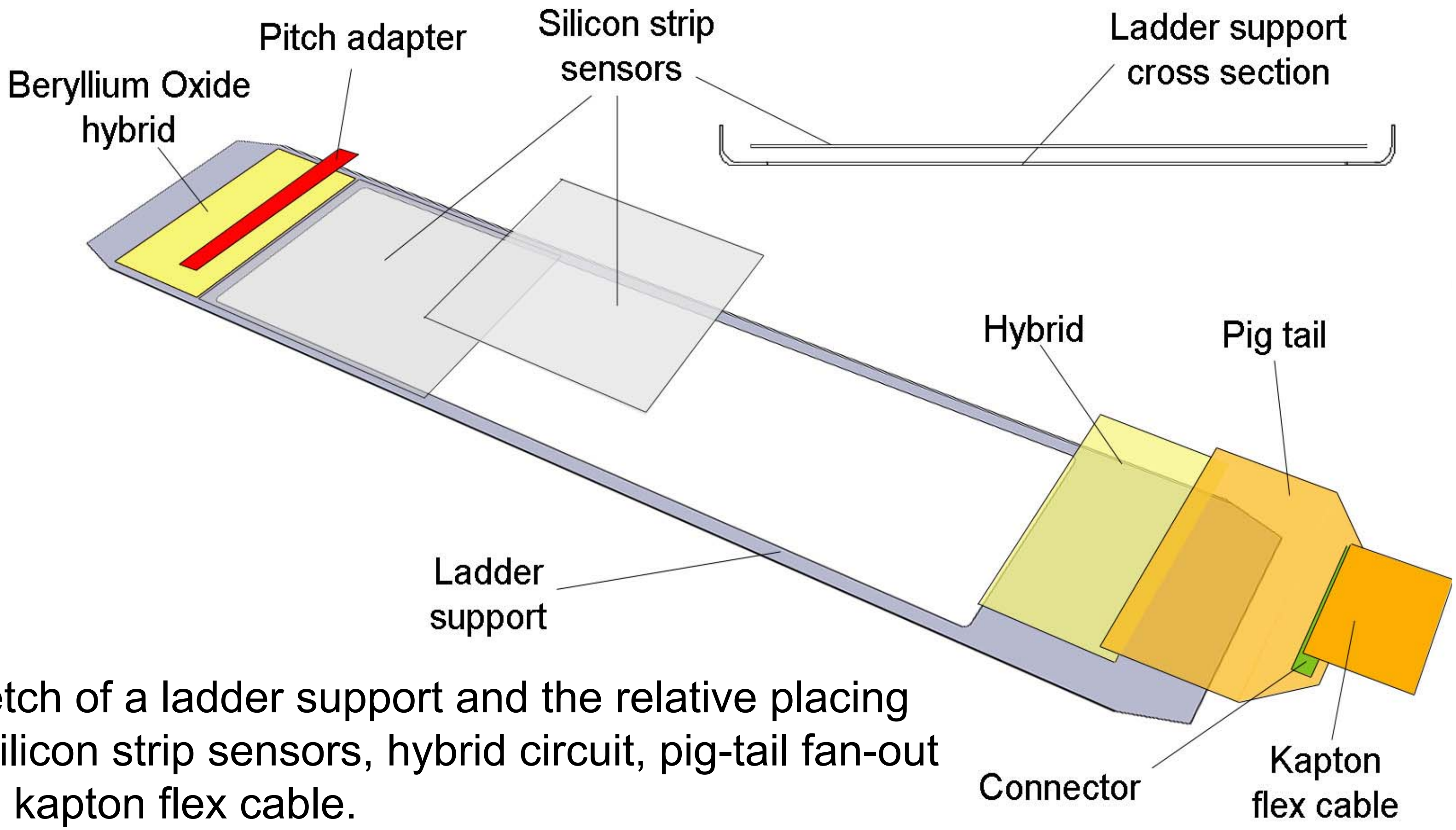
# Silicon Strip Components



Base cost: $7.5M (Material: $3.7M, Labor: $3.8M)

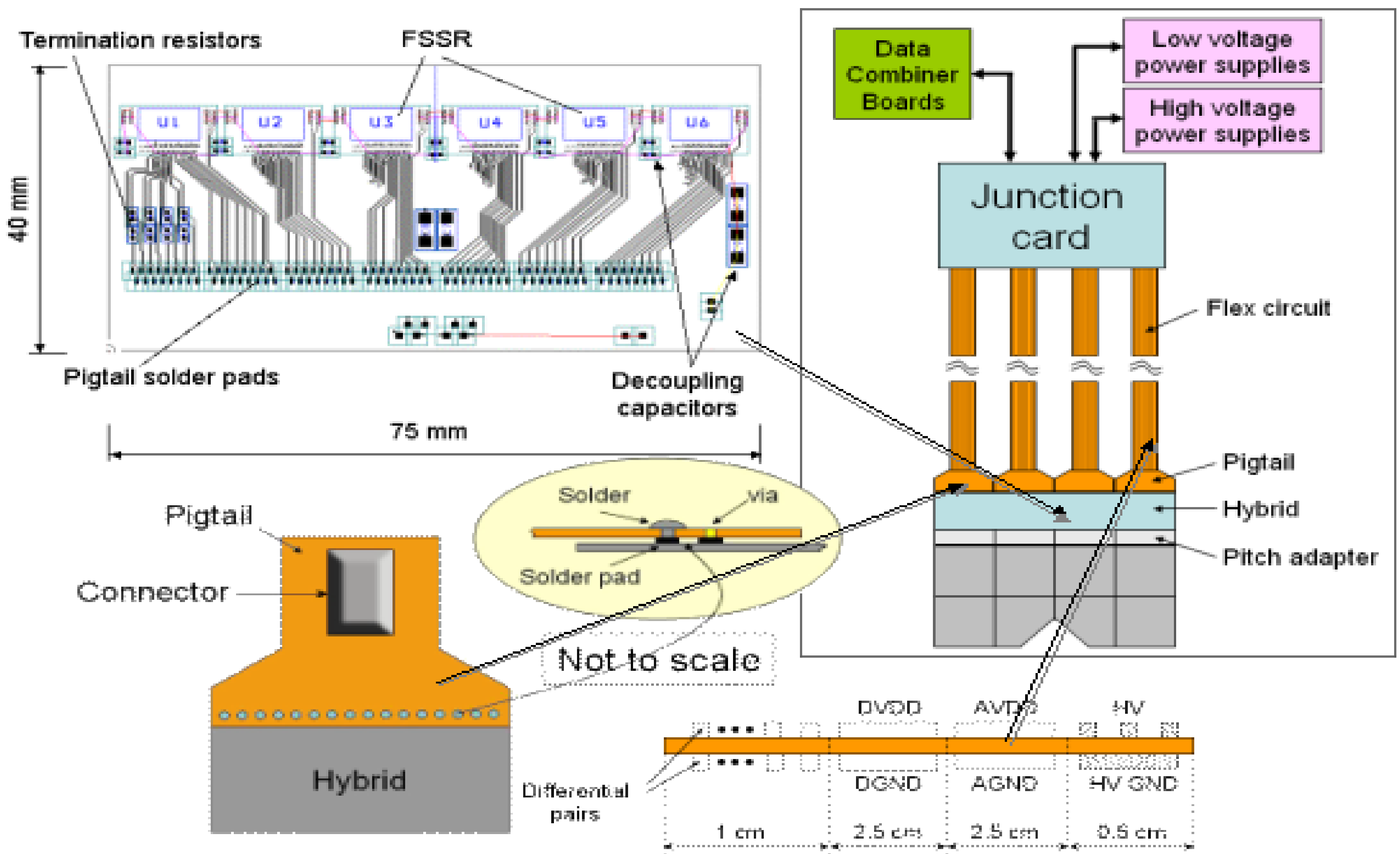
- Sensors
- Readout Chips
- Electronics Packaging & DA
  - Hybrids, Flex's, Junction Cards, Power Supplies, Cabling and DCB's
- Mechanics
  - Inner & Outer Supports
- Cooling
- Ladder Assembly
- System Integration & Testing
  - Detector Prototypes & Tests, Control & Monitor, Detector Specific Software

# Silicon Strip Detector Ladder WBS1.7

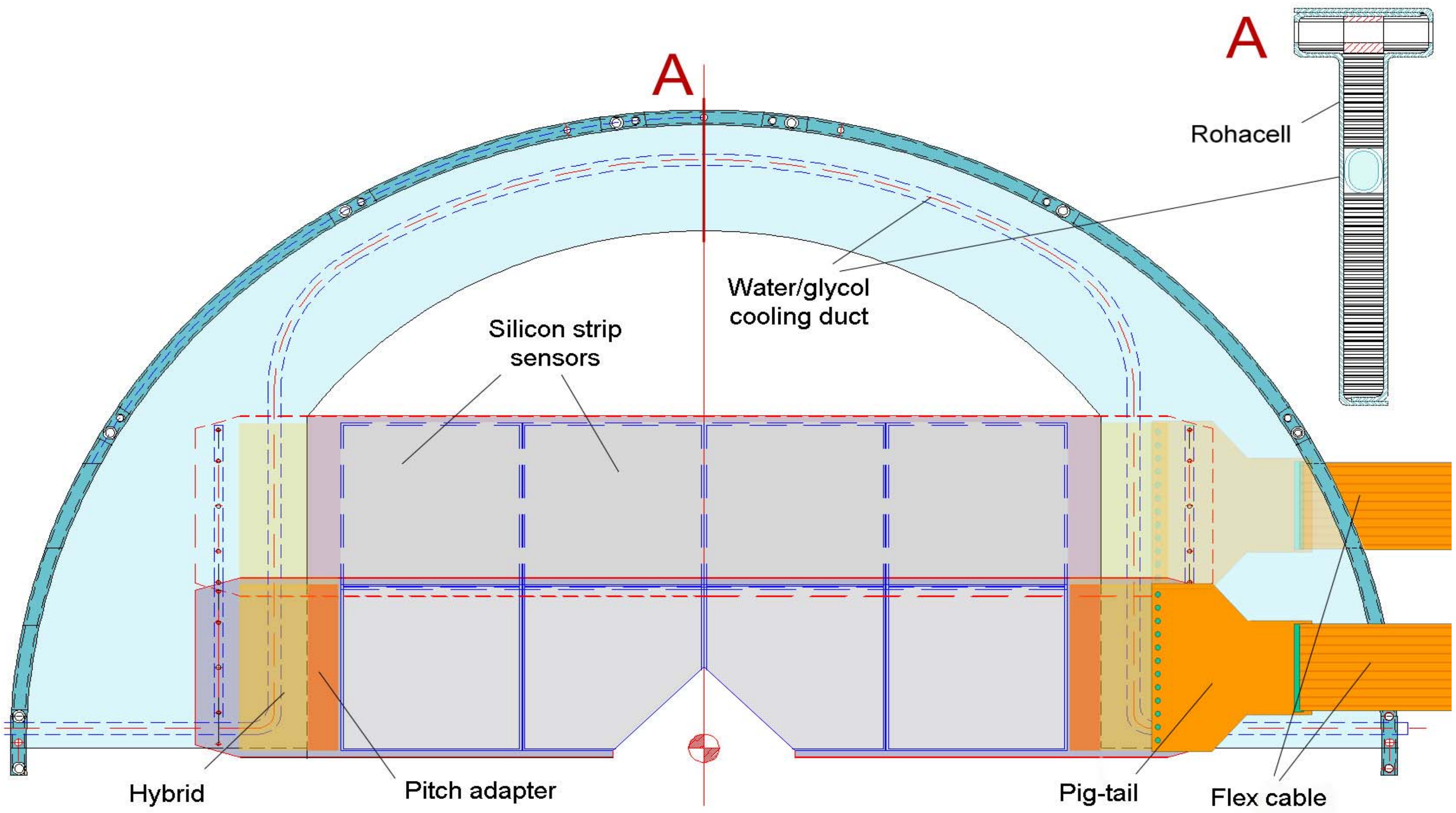


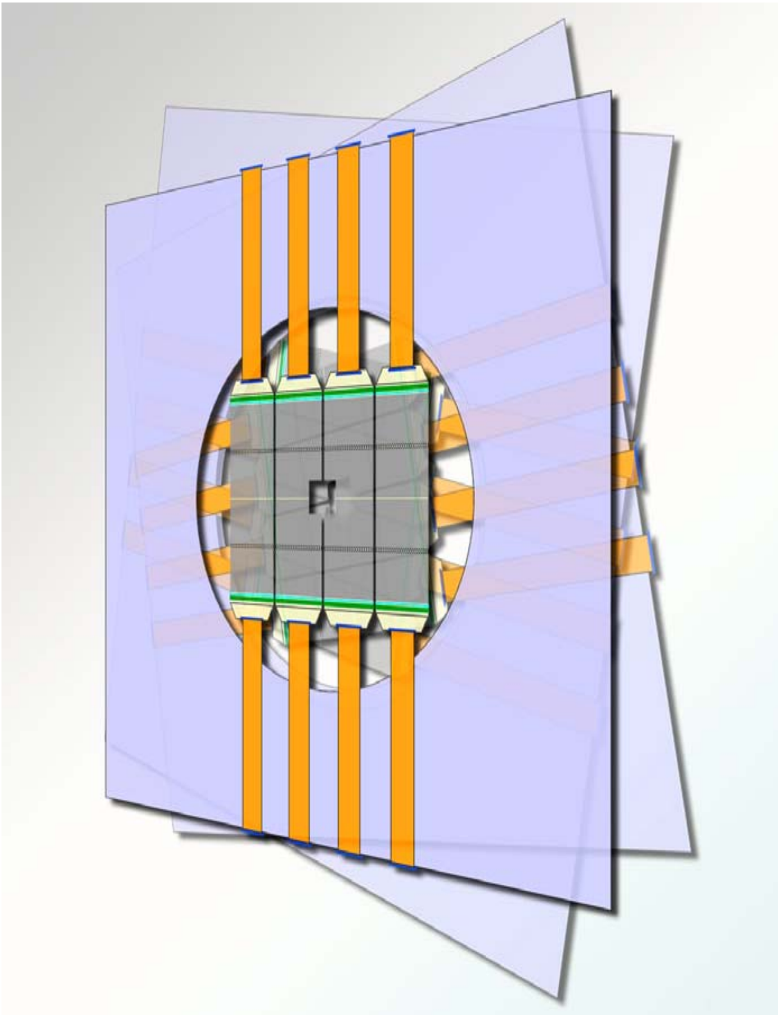

Sketch of a ladder support and the relative placing of silicon strip sensors, hybrid circuit, pig-tail fan-out and kapton flex cable.

## Benefit from CDF RUN IIB experience



# Silicon Strip Detector Half Plane Support WBS1.7





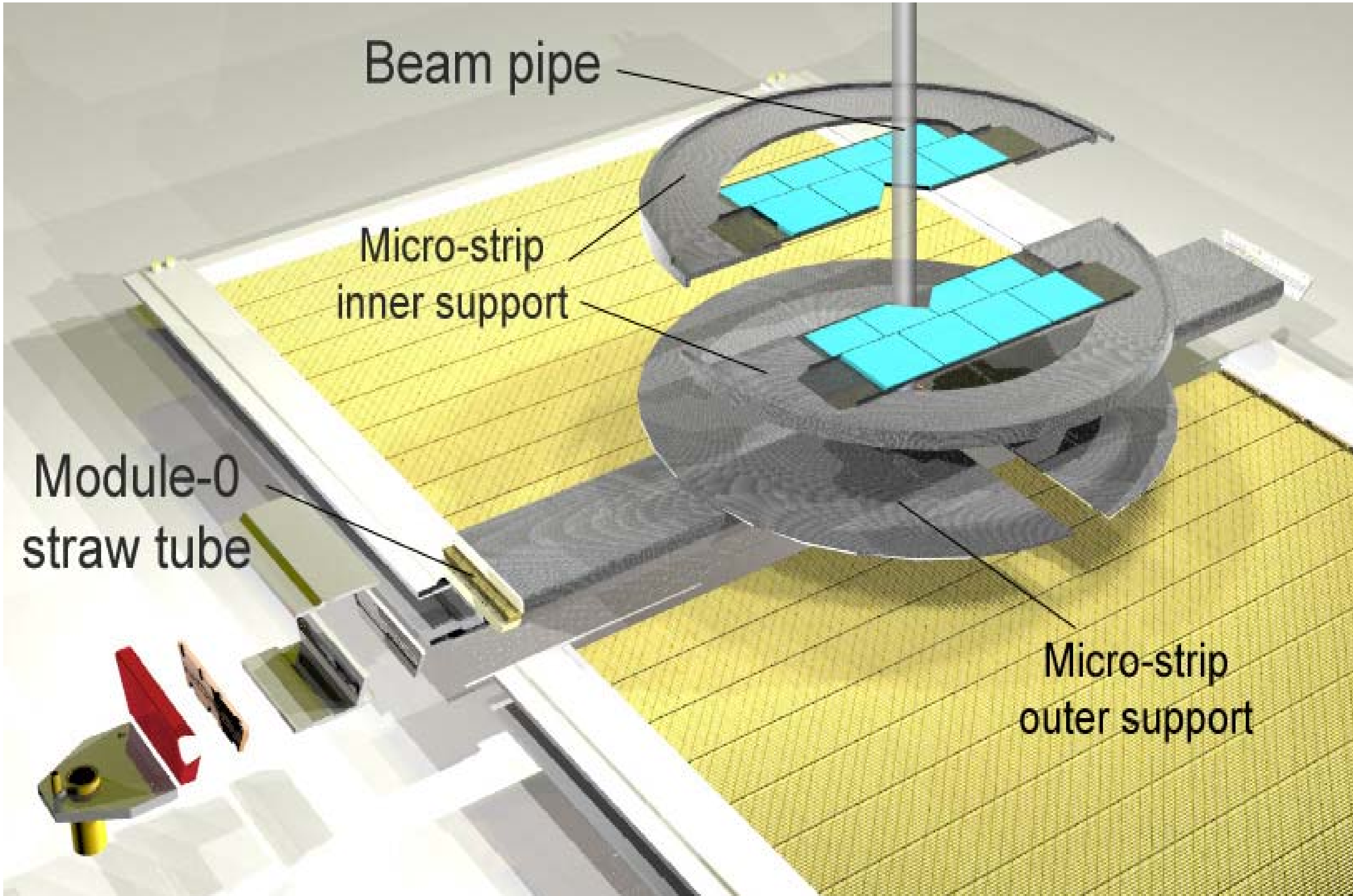
# 3 views:

X: $0^{o}$ (horizontal)

U: $90^{o} + 11.3^{o}$

V: $90^{o} - 11.3^{o}$

# Forward Tracker Station Assembly



# Silicon Tracker Participants WBS 1.7

- Colorado University: J.Cumalat, P.Rankin, Eric Erdos
- Fermilab: J. Andresen, G. Cardoso, C. Gingu, J. Hoff, M. Hrycyk, A. Mekkaoui, R. Yarema, J. Andresen, K. Knickerbocker, A. Dyer
- Frascati: M. Caponero, D. Colonna, A. Paolozzi, F. Fabbri, S. Bianco
- Insubria University: P. Ratcliffe, M. Rovere
- INFN Milano: G. Alimonti, M. Citterio, S. Magni, D. Menasce, L. Moroni, D. Pedrini, S. Sala, S. Erba, P. D'Angelo, S. Latorre, M.Malatesta
- INFN Pavia: G.E. Cossali, P.F. Manfredi, M. Manghisoni, M. Marengo, L. Ratti, V. Re, M. Santini, V. Speziali , D. Di Pietro, G. Traversi , K. Fisher, L. D'Angelo

-Physicist

- Technical staff

# Silicon Tracker Organization WBS 1.7

**WBS 1.7**
**Forward Silicon Tracker**
L2 Manager
**L.Moroni**
Deputy
**J.Cumalat**

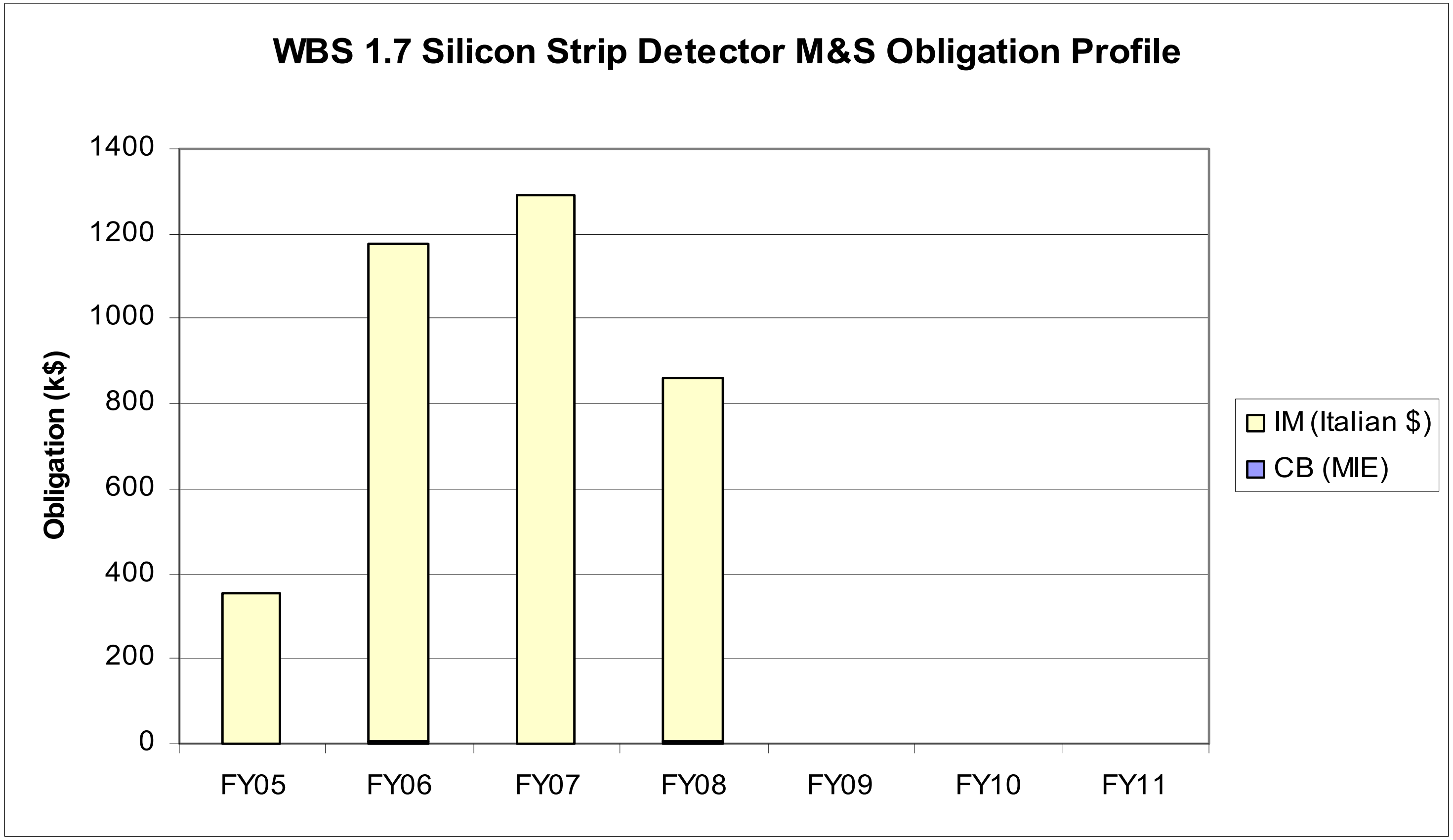
- Sensors
  **L3** Manager
  **S.Sala**
  1.7.1
- Electronics
  **L3** Manager
  **V.Re**
  1.7.2
- Mechanics
  **L3** Manager
  **L.Moroni & J.Cumalat**
  1.7.3
- Cooling
  **L3** Manager
  **E.Cossali**
  1.7.3.6
- System Integration & Testing
  **L3** Manager
  **D.Menasce**
  1.7.4

Base cost: \$7.5M (Material: \$3.7M, Labor: \$3.8M)

# Silicon Tracker Construction Cost WBS1.7

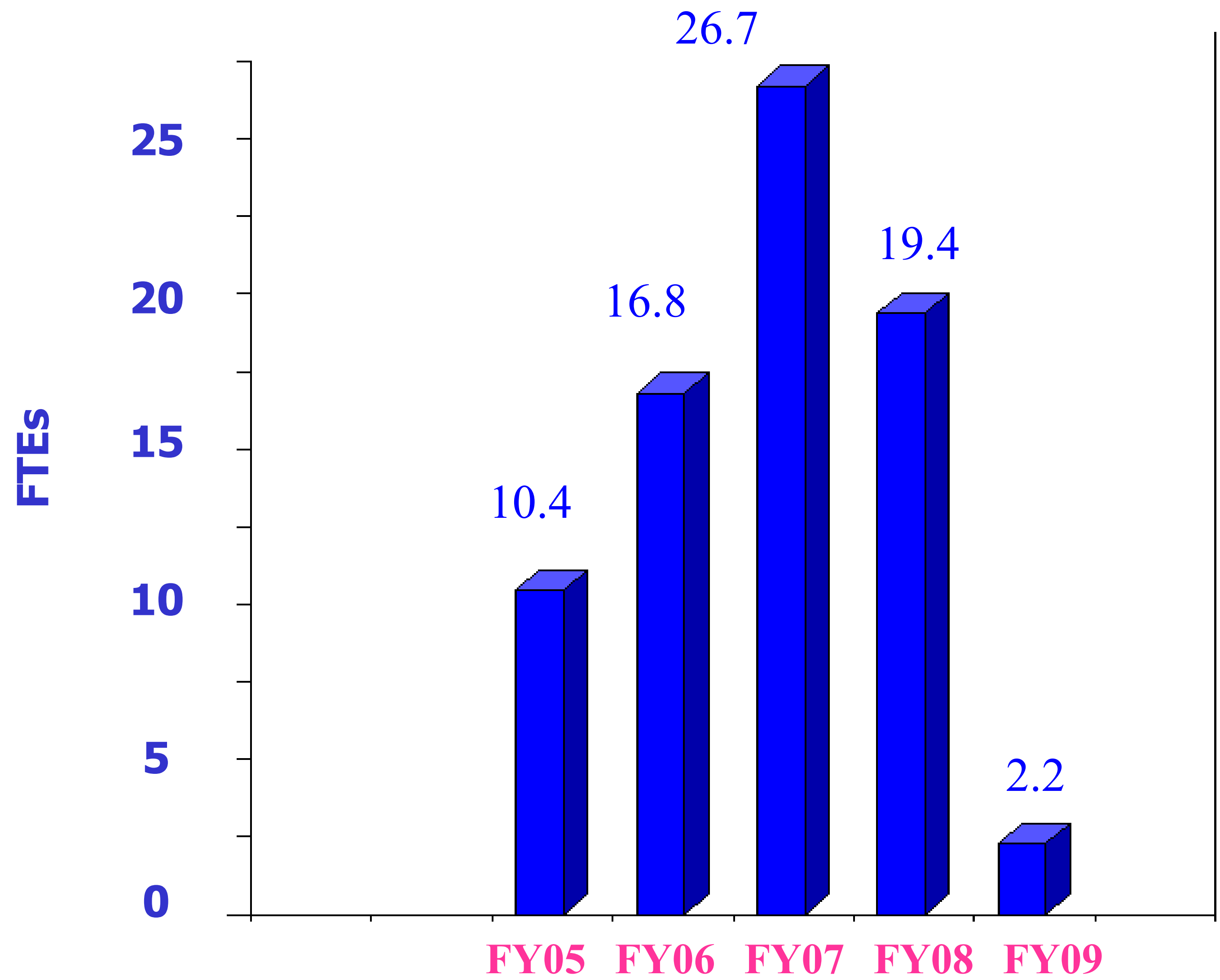
| Activity ID | Activity Name | Base Cost ($) | Material Contingency (%) | Labor Contingency (%) | Total FY05 | Total FY06 | Total FY07 | Total FY08 | Total FY09 | Total FY10 | Total FY05-10 |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 1.7.1 | Sensors (SM) | 1,209,665 | 25 | 29 | 0 | 357,979 | 1,146,983 | 7,129 | 0 | 0 | 1,512,091 |
| 1.7.2 | Electronics | 2,561,906 | 31 | 28 | 651,532 | 1,014,537 | 953,955 | 625,718 | 61,906 | 0 | 3,307,648 |
| 1.7.3 | Mechanics & Cooling | 1,158,348 | 53 | 39 | 165,325 | 402,081 | 443,834 | 630,359 | 47,843 | 0 | 1,689,442 |
| 1.7.4 | Integration | 2,062,839 | 46 | 37 | 574,803 | 565,529 | 630,708 | 1,114,065 | 0 | 0 | 2,885,104 |
| 1.7.5 | Detector Subproj Mgmt | 462,468 | 30 | 27 | 59,044 | 165,454 | 163,507 | 156,598 | 45,509 | 0 | 590,113 |
| | | | | | | | | | | | |
| 1.7 | file_17S_092204 | 7,455,226 | 35 | 33 | 1,450,704 | 2,505,579 | 3,338,988 | 2,533,869 | 155,258 | 0 | 9,984,398 |

# M&S Obligation Profile by Fiscal Year WBS1.7

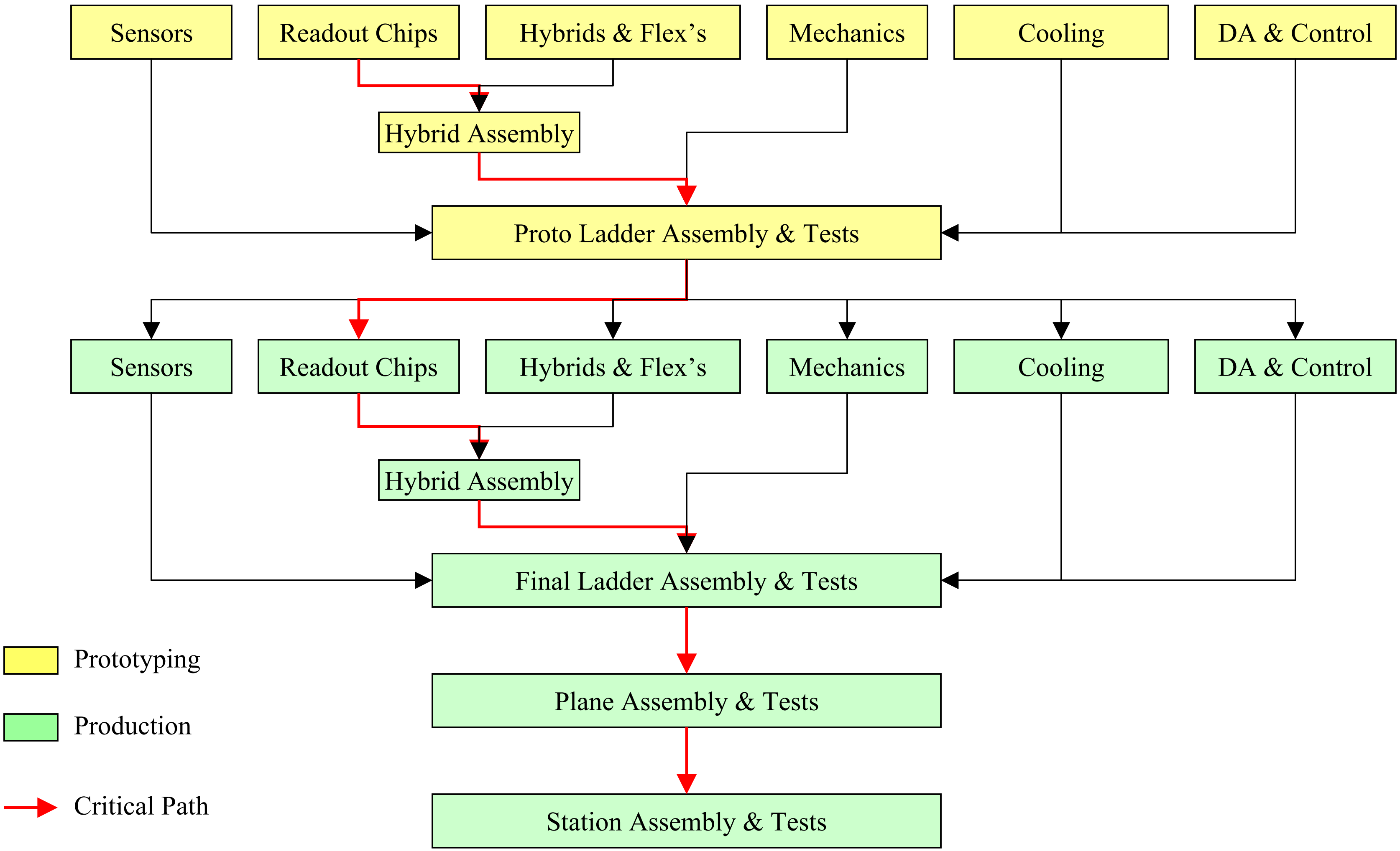



| | FY05 | FY06 | FY07 | FY08 | FY09 |
|---|---|---|---|---|---|
| CB (MIE) | | 4 | | 4 | |
| RD | | | | | |
| IM (Italian $ | 354 | 1171 | 1290 | 855 | |

# Labor Profile by Fiscal Year WBS 1.7



# Description of Project Flow WBS 1.7

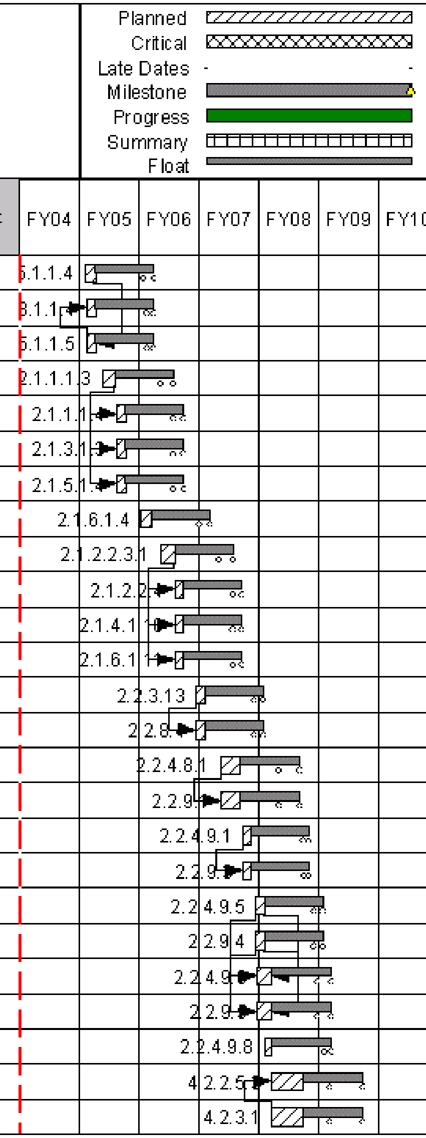


# Gantt Chart for Strip Detector WBS1.7

## BTeV - WBS 1.7 Forward Tracker Strip Detector

**Barchart for Critical Path Analysis**

**Sorted by Float**




| Activity ID | Activity Description | Activity Type | Duration | Float | Early Start | Early Finish | Late Start |
|---|---|---|---|---|---|---|---|
| 2.1.5.1.1.4 | Layout Pass Two IC Des | ASAP | 40d | 247d | 05Nov04 | 07Jan05 | 01Nov05 |
| 2.1.3.1.1.4 | Sim Layout, Incorporate Des Changes & Revise Doc, as necessa | ASAP | 30d | 247d | 19Nov04 | 07Jan05 | 15Nov05 |
| 2.1.5.1.1.5 | Sim Layout, Incorporate Des Changes & Revise Doc, as necessa | ASAP | 30d | 247d | 19Nov04 | 07Jan05 | 15Nov05 |
| 2.1.1.1.3 | Vend Manfucture & Del Pass Two Protos | ASAP | 60d | 247d | 21Feb05 | 13May05 | 08Feb06 |
| 2.1.1.1.4 | Test Pass Two IC Protos | ASAP | 40d | 247d | 16May05 | 12Jul05 | 03May06 |
| 2.1.3.1.3 | Test Pass Two IC Protos | ASAP | 40d | 247d | 16May05 | 12Jul05 | 03May06 |
| 2.1.5.1.4 | Test Pass Two IC Protos | ASAP | 40d | 247d | 16May05 | 12Jul05 | 03May06 |
| 2.1.6.1.4 | Layout Final IC Design | ASAP | 50d | 247d | 13Oct05 | 23Dec05 | 02Oct06 |
| 2.1.2.2.3.1 | Vend Manfucture & Del Pre-Prod Run of Final ICs | ASAP | 60d | 247d | 09Feb06 | 03May06 | 01Feb07 |
| 2.1.2.2.4 | Test Pre-Prod Run of Final ICs | ASAP | 40d | 247d | 04May06 | 29Jun06 | 26Apr07 |
| 2.1.4.1.10 | Test Pre-Prod Run of Final ICs | ASAP | 40d | 247d | 04May06 | 29Jun06 | 26Apr07 |
| 2.1.6.1.11 | Test Pre-Prod Run of Final ICs | ASAP | 40d | 247d | 04May06 | 29Jun06 | 26Apr07 |
| 2.2.3.13 | Test Assembled Preproduction Hybrids for Station Tests | ASAP | 40d | 247d | 12Sep06 | 06Nov06 | 04Sep07 |
| 2.2.8.4 | Test Assembled Preproduction Hybrids for Station Tests | ASAP | 40d | 247d | 12Sep06 | 06Nov06 | 04Sep07 |
| 2.2.4.8.1 | Manufacture 1st Shipment of Hybrid | ASAP | 90d | 247d | 08Feb07 | 14Jun07 | 04Feb08 |
| 2.2.9.1 | Manufacture 1st Shipment of Hybrid | ASAP | 90d | 247d | 08Feb07 | 14Jun07 | 04Feb08 |
| 2.2.4.9.1 | Manufacture Final Shipment of Hybrid | ASAP | 30d | 247d | 03Jul07 | 14Aug07 | 26Jun08 |
| 2.2.9.3 | Manufacture Final Shipment of Hybrid | ASAP | 30d | 247d | 03Jul07 | 14Aug07 | 26Jun08 |
| 2.2.4.9.5 | Vend Assembles & Tests Hybrids for Ladder Production | ASAP | 40d | 247d | 13Sep07 | 07Nov07 | 08Sep08 |
| 2.2.9.4 | Vend Assembles & Tests Hybrids for Ladder Production | ASAP | 40d | 247d | 13Sep07 | 07Nov07 | 08Sep08 |
| 2.2.4.9.6 | Test Assembled Production Hybrids for Ladder Production | ASAP | 60d | 247d | 27Sep07 | 21Dec07 | 22Sep08 |
| 2.2.9.5 | Test Assembled Production Hybrids for Ladder Production | ASAP | 60d | 247d | 27Sep07 | 21Dec07 | 22Sep08 |
| 2.2.4.9.8 | Prod Hybrids ready for Ladder Assembly | ASAP | 30d | 247d | 08Nov07 | 21Dec07 | 03Nov08 |
| 4.2.2.5.3 | Test Ladder Prod at SiDet | ASAP | 138d | 247d | 17Dec07 | 03Jul08 | 10Dec08 |
| 4.2.3.1 | Assemble & Test Ladders at SiDet | ASAP | 138d | 247d | 17Dec07 | 03Jul08 | 10Dec08 |

# Critical Path Analysis Without Distributed Float



- Staged Installation
  - Stage 1: Stations 1, 2, 6, and 5 in FY09 shutdown
  - Stage 2: Rest of the stations in FY10 shutdown
- The shortest Total Float in the Forward Silicon Strip project is 247 days (for FY09 shutdown)
  - i.e. any delay up to 12 months can be absorbed by our schedule without impacting the deadline for installation.
  - Stations that will be installed in FY10 will have a minimum float of 449 days.

# Response to CD-1 Review Recommendations WBS1.7

- From CD-1 Report:
  - The silicon strip tracking detector was **found to be in good shape** at the CD-1 review. The positive news about **INFN funding** makes the schedule for the silicon strip tracker **even more robust.**
- Indeed all the funding constraints were removed from the schedule and the float went from 112 days up to 247 days.
  - About 1 year delay can be safely absorbed!

# Summary for WBS 1.2, WBS 1.6, and WBS 1.7

More information on the Pixel (WBS 1.2), Straw (WBS 1.6) and Silicon Strip Tracker (WBS 1.7) is available in the breakout sessions.

## WBS 1.2

- **Overview – D. Christian**
- **Sensor & hybridization – S. Kwan**
- **Electronics – G. Cardoso**
- **Substrate & half-plane assembly – CM Lei**
- **Vacuum system – H. Cease**
- **Pixel Detector assembly – J. Fast**
- **Test beam – C. Newsom**
- **Cost and Schedule – S. Kwan**

## WBS 1.7

- **Overview – L. Moroni**
- **Readout chip – V. Re**
- **Readout electronics – G. Cardoso**
- **FBG sensors for BTeV Tracking Detectors – S. Bianco**
- **Cost and Schedule – L. Moroni**

## WBS 1.6

- **Activities at University of Houston (K.Lau)**
- **Module 0X (S. Bianco)**
- **Activities at SMU (T.Coan)**
- **Activities at UVa (B.Cox)**
- **Latest results from Straw Test Beam Run (A.Ledovskoy)**
- **Acoustic Method for Wire Tension Measurement (M. Hosack)**
- **BTeV Straw Design and Prototyping Efforts (A.Hahn)**
- **Straw Chamber Assembly (Y. Orlov)**
- **BTeV Straw Detector Simulations (P.Kasper)**
- **Straw Response to Lehman CD1 (A.Hahn)**

# Conclusion

- The BTeV tracking system has three elements: Pixel vertex detector, forward silicon tracker, and forward straw detector
- For all three detectors:
  - Baseline technical designs exist
  - Organization structure established
  - Detailed WBS leading to a base cost estimate and resource-loaded schedule for the construction of the baseline detector
  - We are ready to move on to the next phase of the project

# Backup Slides

# Pixel Glossary of Terms
# WBS1.2

- HDI – High Density Interconnect
- PIFC – Pixel Interconnect Flex Cable
- FTB – Feed-through Board
- TPG – Thermal Pyrolytic Graphite
- PGS – Pyrolytic Graphite Sheet
- LN2 – Liquid Nitrogen
- LHe – Liquid Helium

# Straw Glossary of Terms WBS 1.6

- Module : basic construction unit consisting of 48 straws
- Half-Views: Each Straw Station is made of 3 views (X, U, V). Each View is divided into two "Half-Views", in order to install detector around an existing beam pipe. Each Half-View is an independent working detector.
- ASDQ chip – Amplfier, Shaper, Discriminator and Charge chip; designed by the Upenn group and used in CDF COT
- MOX – Module O (closest to the beam pipe) X view

- FSSR: Fermilab Silicon Strip Readout Chip
- DCB: Data Combiner Board (note: Pixel and silicon strip will use the same type of DCB)
- DA: Data Acquisition
- FBG: Fiber Bragg Grating

# Key Milestones Without Distributed Float



| Milestone | Date |
|---|---|
| T2M-3: Contract awarded for production pixel sensors | Aug 24, 2005 |
| T2M-2: Contract awarded for production pixel readout chips | Nov 10, 2005 |
| T1M-4: Contract awarded for production pixel detector hybridization | Mar 21, 2006 |
| T3M-13: Vacuum System designed & approved for construction | May 14, 2007 |
| T3M-14: Final pixel detector assembly started | Mar 27, 2007 |
| T3M-15 Pixel modules completed (assembly & testing) | Nov 1, 2007 |
| T1M-6: Pixel detector tested & ready to be shipped to C0 | Aug 6, 2008 |

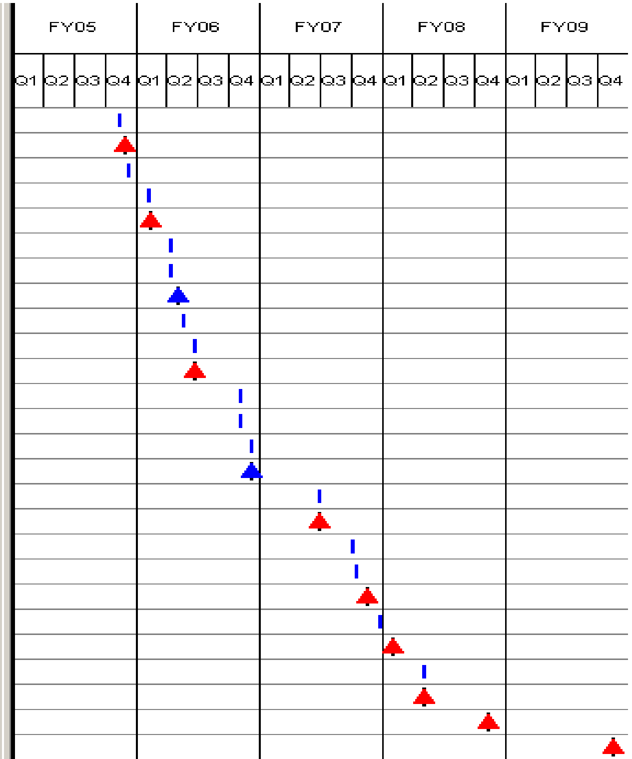
Need-by Date: August 17, 2009

Total Float: 259 days

- Schedule contingency
  - Placed before key milestones or activities on critical or near critical path
  - Nominally zero duration
  - Distribute float throughout the duration of the project
  - Typically increase duration of activity by 20 to 30%.

11Aug05

| WBS | Activity Desc. | Early Start | Early Finish | Sch. Cont. | Total Float |
|---|---|---|---|---|---|
| 1.2.1.3.1.3.1 | SC: Production sensor order schedule contingency task | 11Aug05 | 11Aug05 | 30d | 295d |
| 1.2.1.3.1.3.6 | T2M: Release funds for Production pixel sensors | 24Aug05 | 24Aug05 | | 306d |
| 1.2.3.2.2.7.3 | SC: Substrate design schedule contingency | 06Sep05 | 06Sep05 | 50d | 291d |
| 1.2.2.1.7.8.1 | SC: Production PRC schedule contingency | 04Nov05 | 04Nov05 | 30d | 264d |
| 1.2.2.1.7.8.3 | T2M: Release fund for production pixel ROC | 10Nov05 | 10Nov05 | | 319d |
| 1.2.1.3.1.4.2.7 | SC: Production sensor delivery schedule contingency task | 10Jan06 | 10Jan06 | 30d | 334d |
| 1.2.1.3.1.5.2.7 | SC: Production sensor delivery schedule contingency task | 11Jan06 | 11Jan06 | 30d | 438d |
| 1.2.2.1.7.9 | T5M: Receive all FPIX wafers | 31Jan06 | 31Jan06 | | 279d |
| 1.2.1.5.2.1.1 | SC: Pre-Production pixel detectors test schedule contingency | 17Feb06 | 17Feb06 | 20d | 182d |
| 1.2.1.6.1.1.1.6 | SC: Production detector hybridization procurement contingency task | 21Mar06 | 21Mar06 | 20d | 262d |
| 1.2.1.6.1.2.2 | T2M:Release funds for production detector hybridization | 21Mar06 | 21Mar06 | | 262d |
| 1.2.4.1.4.7.4 | SC: Production pixel module assembly/test schedule contingency | 03Aug06 | 03Aug06 | 30d | 363d |
| 1.2.3.6.3.10.3 | SC: Cooling system design schedule contingency | 04Aug06 | 04Aug06 | 50d | 369d |
| 1.2.1.3.1.5.3.7 | SC: Production sensor schedule contingency | 05Sep06 | 05Sep06 | 30d | 438d |
| 1.2.1.3.1.6 | T4M: Production sensor wafers completely delivered & tested | 05Sep06 | 05Sep06 | | 438d |
| 1.2.4.3.6.2.7 | SC: Pixel station assembly schedule contingency | 27Mar07 | 27Mar07 | 30d | 262d |
| 1.2.4.3.6.2.8 | T2M: Final pixel detector station assembly started | 27Mar07 | 27Mar07 | | 262d |
| 1.2.4.4.8.2.4 | SC: Pixel half-detector assembly/test schedule contingency | 03Jul07 | 03Jul07 | 20d | 268d |
| 1.2.1.6.1.2.7.5.4 | SC: Production detector hybridization delivery schedule contingency | 16Jul07 | 16Jul07 | 60d | 289d |
| 1.2.1.6.1.2.8 | T4M: Receive all Production pixel detectors | 13Aug07 | 13Aug07 | | 268d |
| 1.2.1.6.5.3 | SC: Production pixel detector testing schedule contingency task | 20Sep07 | 20Sep07 | 20d | 262d |
| 1.2.4.1.4.10 | T2M: Production Pixel Module Completed | 31Oct07 | 31Oct07 | | 263d |
| 1.2.4.3.7.5 | SC: Pixel station test schedule contingency | 29Jan08 | 29Jan08 | 15d | 262d |
| 1.2.4.3.7.6 | T4M: All pixel stations assembled & tested | 29Jan08 | 29Jan08 | | 262d |
| 1.2.7.2.2 | T1M-6: Pixel System Tested/ Ready for Installation at C0 | 07Aug08 | 07Aug08 | | 258d |
| 1.2.6.4.2.19 | Lk4M: Installation Need-by date for Pixel detector | 17Aug09 | 17Aug09 | | 0 |



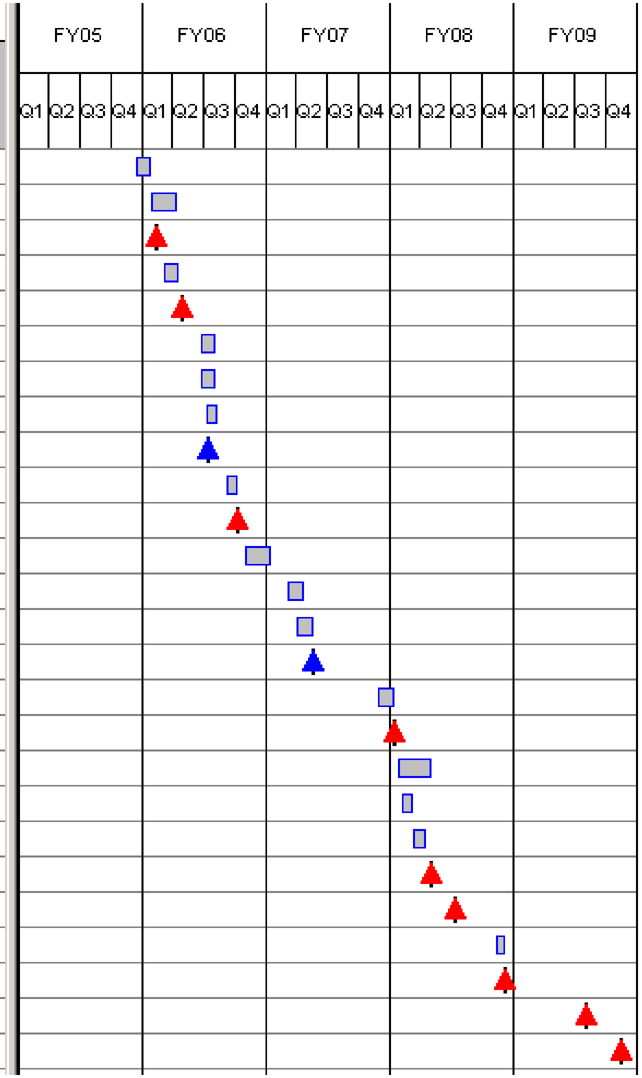
# Critical Activities Gantt Chart With Distributed Float

## WBS1.2

25Oct05

| WBS | Activity Desc. | Early Start | Early Finish | Sch. Cont. | Total Float |
|---|---|---|---|---|---|
| 1.2.1.3.1.3.1 | SC: Production sensor order schedule contingency task | 14Sep05 | 25Oct05 | 30d | 118d |
| 1.2.3.2.2.7.3 | SC: Substrate design schedule contingency | 01Nov05 | 11Jan06 | 50d | 166d |
| 1.2.1.3.1.3.6 | T2M: Release funds for Production pixel sensors | 08Nov05 | 08Nov05 | | 122d |
| 1.2.2.1.7.8.1 | SC: Production PRC schedule contingency | 06Dec05 | 16Jan06 | 30d | 82d |
| 1.2.2.1.7.8.3 | T2M: Release fund for production pixel ROC | 23Jan06 | 23Jan06 | | 137d |
| 1.2.1.3.1.4.2.7 | SC: Production sensor delivery schedule contingency task | 24Mar06 | 04May06 | 30d | 138d |
| 1.2.1.3.1.5.2.7 | SC: Production sensor delivery schedule contingency task | 27Mar06 | 05May06 | 30d | 212d |
| 1.2.1.5.2.1.1 | SC: Pre-Production pixel detectors test schedule contingency | 11Apr06 | 08May06 | 20d | 72d |
| 1.2.2.1.7.9 | T5M: Receive all FPIX wafers | 11Apr06 | 11Apr06 | | 116d |
| 1.2.1.6.1.1.1.6 | SC: Production detector hybridization procurement contingency task | 09Jun06 | 07Jul06 | 20d | 72d |
| 1.2.1.6.1.2.2 | T2M:Release funds for production detector hybridization | 10Jul06 | 10Jul06 | | 72d |
| 1.2.3.6.3.10.3 | SC: Cooling system design schedule contingency | 04Aug06 | 13Oct06 | 50d | 264d |
| 1.2.4.1.4.7.4 | SC: Production pixel module assembly/test schedule contingency | 07Dec06 | 22Jan07 | 30d | 166d |
| 1.2.1.3.1.5.3.7 | SC: Production sensor schedule contingency | 04Jan07 | 15Feb07 | 30d | 212d |
| 1.2.1.3.1.6 | T4M: Production sensor wafers completely delivered & tested | 15Feb07 | 15Feb07 | | 212d |
| 1.2.4.3.6.2.7 | SC: Pixel station assembly schedule contingency | 30Aug07 | 11Oct07 | 30d | 72d |
| 1.2.4.3.6.2.8 | T2M: Final pixel detector station assembly started | 11Oct07 | 11Oct07 | | 72d |
| 1.2.1.6.1.2.7.5.4 | SC: Production detector hybridizat[illegible] | [illegible] | [illegible] | [illegible]d | 72d |
| 1.2.4.4.8.2.4 | SC: Pixel half-detector assembly/test schedule contingency | 08Nov07 | 07Dec07 | 20d | 123d |
| 1.2.1.6.5.3 | SC: Production pixel detector testing schedule contingency task | 12Dec07 | 14Jan08 | 20d | 105d |
| 1.2.1.6.1.2.8 | T4M: Receive all Production pixel detectors | 01Feb08 | 01Feb08 | | 72d |
| 1.2.4.1.4.10 | T2M: Production Pixel Module Completed | 11Apr08 | 11Apr08 | | 103d |
| 1.2.4.3.7.5 | SC: Pixel station test schedule contingency | 14Aug08 | 04Sep08 | 15d | 72d |
| 1.2.4.3.7.6 | T4M: All pixel stations assembled & tested | 04Sep08 | 04Sep08 | | 72d |
| 1.2.7.2.2 | T1M-6: Pixel System Tested/ Ready for Installation at C0 | 06May09 | 06May09 | | 72d |
| 1.2.6.4.2.19 | Lk4M: Installation Need-by date for Pixel detector | 17Aug09 | 17Aug09 | | 0 |

T2M: Final pixel detector station assembly started



# Straw Risk Analysis WBS1.6

| Risk Event | Mitigation |
| --- | --- |
| Major Construction Problems with Half View Production | The best strategy is to have a robust production prototype construction so that we can identify production problems before we actually enter production. A standby strategy is to have backup sites which could contribute to Half-View production once their original function is accomplished. For example, once the Straw Preparation Facility has finished, it could convert to a Half-View Assembly site. |
| Process to produce ASDQ chips is shutdown, by the time our budget profile allows us to place order. | We need to identify a source of funds that allows us to commit to a wafer run as early in the project as possible-while the current wafer process still exists. We could delay the packaging to later in the project timeline, when more funds become available. |

# Straw Level 2&3 Milestones [+] WBS1.6

| WBS1.6 | Forward Straw Tracker | Date |
| --- | --- | --- |
| 1.6.7.4.1 | T3M-38:PO Awarded: Production ASDQ Chips * | October 10, 2005 |
| 1.6.7.4.2 | T3M-39:ASDQ Procurement completed | August 3, 2006 |
| 1.6.7.4.3 | T3M-40:Straw Preparation Site Functional | March 7, 2006 |
| 1.6.7.4.4 | T3M-41: Half-View Production/ Assembly Sites Functional | February 7, 2007 |
| 1.6.7.4.5 | T3M-42: Station 1 ready for Installation * | April 3, 2008 |
| 1.6.7.4.6 | T3M-43: Station 7 ready for Installation | June 12, 2008 |

* Also a Level 2 Milestone

[+] without Distributed Float

# Risk Analysis



- Risks

  1. 0.25μm CMOS process disappears before we go into production

- Mitigation

  1. Work with multiple vendors. Keep in close contact with vendors to understand their future plans.

# Key Milestones WBS 1.7
# Without Distributed Float

| Milestone | Date |
|---|---|
| T3M-44 Sensor accepted for full production | Jan 10, 2007 |
| T3M-45: Production sensors received and tested | Oct 18, 2007 |
| T3M-46: Readout IC approved for production | Aug 3, 2006 |
| T3M-48: Production ICs Received tested and thinned | Feb 8, 2007 |
| T3M-49: Hybrids approved for production | Nov 13, 2006 |
| T3M-50: Hybrids complete and tested | Jan 3, 2008 |
| T3M-51: Station support procurement complete | Oct 3, 2008 |
| T3M-52: Ladder production 100% Complete | Jul 8, 2008 |
| T3M-53: First FSIL station ready to be installed in C0 | Aug 27, 2008 |
| T3M-54: Last FSIL station ready to be installed in C0 | Sep 15, 2008 |